United States Environmental Protection Agency

EPA Region 6 Announces Proposed Plan

San Jacinto River Waste Pits Site
Harris County, T
exas
September 2016

The Purpose of this Proposed Plan is to:

- Identify the United States Environmental Protection Agency's (EPA's) preferred remedial alternative to address risks associated with contaminants in fish, sediment, and soil at the San Jacinto River Waste Pits Site;
- Provide the results of the Remedial Investigation and Risk Assessments;
- Describe the remedial alternatives evaluated in the Feasibility Study Report;
- Solicit public review and comment on the remedial alternatives and information contained in the Administrative Record file; and
- Provide information on how the public can be involved in the remedy selection process.

In this Proposed Plan, the EPA presents a summary of the risks (pages 10 to 13) associated with the hazardous substances at the San Jacinto River Waste Pits Site (hereinafter the "Site"), a summary of remedial alternatives (pages 13 to 21), and the preferred alternative (pages 27 and 28) to address the contamination at the Site.

The Site, located in Harris County, Texas (Figure 1), consists of a set of impoundments built in the mid-1960s for the disposal of solid and liquid pulp and paper mill wastes, and the surrounding areas containing sediments and soils impacted by waste materials disposed in the impoundments. The northern set of impoundments, approximately 14 acres in size, are located on the western bank of the San Jacinto River, north of the Interstate-10 (I-10) Bridge over the San Jacinto River (Figure 2). These northern impoundments are partially submerged in the river. The southern impoundment, less than 20 acres in size, is located on a small peninsula that extends south of I-10. The wastes that were deposited in the impoundments are contaminated with polychlorinated dibenzo-p-dioxins (dioxins) and polychlorinated dibenzofurans (furans). The Preferred Remedy for cleaning up the Site is Alternative 6N (Full Removal of Materials Exceeding Cleanup Levels and Institutional Controls) for the northern impoundments and aquatic area, and Alternative 4S (Removal and Offsite Disposal with Institutional Controls) for the southern impoundment. The institutional controls will be developed, implemented, and maintained in accordance with EPA's Institutional Controls guidance (OSWER Directive 9355.0-89)

The EPA is issuing this Proposed Plan to solicit public comment on the remedial alternatives. This Proposed Plan is being issued in accordance with and as part of its public participation responsibilities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) §117(a), 42 U.S.C. § 9617(a) and the Code of Federal Regulations (CFR) § 40 CFR §300.430(f)(2). The recommendations and alternatives set forth in this Proposed Plan are based on information and documents contained in the Administrative Record file for the Site. EPA will select a final remedy for the Site after the public comment period has ended and the comments have been reviewed and

carefully considered. EPA may select a different alternative or a modified version of the Preferred Remedy based on new information or public comments.

The EPA Region 6 office is the lead agency for this Site. The Texas Commission on Environmental Quality (TCEQ) is the support agency.

Community Participation

This Proposed Plan highlights information contained in the Administrative Record for the Site. The Administrative Record includes the Remedial Investigation (RI) Report, risk assessment reports, the Feasibility Study (FS) Report, and other documents and reports used in the preparation of this Proposed Plan.

The EPA encourages the public to review these documents to obtain more information about the Superfund activities that have been conducted. The EPA also encourages the public to participate in the decision-making process for the Site.

How to Submit Public Comment

EPA will accept written comments on the Proposed Plan during the public comment period. A 30-day public comment period on this Proposed Plan and the information contained in the Administrative Record file begins on September 7, 2016 and closes on October 6, 2016. Written comments postmarked no later than October 6, 2016 should be sent to:

Gary Miller
EPA Remedial Project Manager
EPA Region 6 (6SF-RA)
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202
(214)-665-8318; miller.garyg@epa.gov

If requested, EPA may extend the comment period. Any request for an extension must be made in writing and received no later than October 6, 2016.

The Administrative Record file, along with the Site's profile page, is available on the internet at the following website:

https://www.epa.gov/tx/san-jacinto-river-waste-pits-superfund-site

The Administrative Record file is also available at the following information repository locations:

Highlands Public Library
Stratford Branch Library
509 Stratford Street
Highlands, Texas 77562
(281) 426-3521

U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Suite 700
Dallas, Texas 75202
(800) 533-3508

Texas Commission on Environmental Quality
Central File Room
12100 Park 35 Circle, Building E
Austin, Texas 78753
(512) 239-2900

The EPA will hold a public meeting to inform residents of the proposed remedy and obtain comments on the Proposed Plan. The public meeting is being held in a fully accessible facility. Should you have questions about

EPA Community Involvement Coordinator
Donn Walters
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Satya Dwivedula
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this facility's compliance with the Americans with Disabilities Act, please contact the EPA Community Involvement Coordinator (contact information provided below). For specific information about the TCEQ's participation in the Superfund process, please contact the TCEQ Project Manager (contact information provided below).

Contaminated Media

Improper disposal of paper mill wastes have resulted in contaminated sediment, soil, and fish.

National Priorities Listing

The site was proposed for listing on the National Priorities List on 19 September 2007, and was placed on the list effective 19 March 2008 (73 FR 14723).

Site Background

In the 1960s, McGinnes Industrial Management Corporation transported liquid and solid pulp and paper mill wastes by barge from the Champion Papers, Inc. paper mill in Pasadena, Texas to impoundments located north of I-10, adjacent to the San Jacinto River, where the waste was stabilized and disposed. Champion Papers, Inc. business records indicate the paper mill produced pulp and paper using chlorine as a bleaching agent. The pulp bleaching process forms dioxins and furans as by-products. The northern impoundments were used for waste disposal from September 1965 to May 1966. Details regarding the southern impoundment are less well known; however, the impoundment was likely constructed sometime between 1962 and 1964 based on evidence of berms visible in historical photos. Sand mining also occurred in the vicinity of the Site.

Early Investigations

Between 1993 and 1995, the City of Houston conducted a toxicity study of the Houston Ship Channel that included the San Jacinto River. Sediment, fish, and crab samples collected near the Site indicated elevated dioxin and furan levels.

Between 2002 and 2004, the TCEQ conducted a study of total maximum daily loads (TMDL) for dioxins and furans in the Houston Ship Channel. Sediment, fish, and crab samples indicated the presence of dioxin and furan contamination in the San Jacinto River surrounding the Site. In April 2005, the Texas Parks and Wildlife Department sent a letter notifying TCEQ of the existence of former waste pits in a sandbar in the San Jacinto River north of I-10. The letter included: 1) discussion of anecdotal evidence, that indicated the pits were likely used from the mid-1960's to mid-1970's for disposal of paper mill waste; 2) data collected during the Houston Ship Channel Toxicity Study and TMDL study, discussed in the paragraph above; 3) documentation of U.S. Army Corps of Engineers (USACE) dredge and fill permits in the area; and 4) requested that TCEQ further investigate the Site.

A preliminary assessment and screening site inspection was conducted between 2005 and 2006 to determine if the Site was eligible for proposal to the National Priorities List. Sediment sample results indicated elevated concentrations of dioxin congeners. The former surface impoundments were identified as the source of hazardous substances at the Site. Following this assessment and inspection, the Site was added to the National Priorities List.

Unilateral Administrative Order for Remedial Investigation/Feasibility Study

On 20 November 2009, the EPA issued a Unilateral Administrative Order (UAO) to International Paper Company and McGinnes Industrial Management Corporation. International Paper Company is the successor to Champion Papers, Inc. Champion Papers, Inc. had arranged for the disposal of the paper mill waste materials containing dioxin that were disposed of at the Site. The paper mill waste is a hazardous substance, but is not a listed or characteristic RCRA hazardous waste. McGinnes Industrial Maintenance

Corporation operated the waste disposal facility at the time of disposal of the waste. The UAO directed International Paper Company and McGinnes Industrial Management Corporation to conduct a RI/FS in accordance with provisions of the order, CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and EPA guidance.

Between 2010 and 2013, site-specific data were collected for the RI. The RI included the collection of paper mill waste, sediment, tissue (i.e., hardhead catfish, Gulf killifish, rangia clam, and blue crabs), soil, and groundwater samples for analyses including dioxins and furans, polychlorinated biphenyls (PCBs) as Aroclors, metals, semivolatile organic compounds, volatile organic compounds, and pesticides. Physical data collected during the RI included: a bathymetric survey, current velocity, material, geotechnical, riverbed properties, sediment loading, erosion rates of cohesive sediment, and net sedimentation rates.

Administrative Settlement Agreement and Order on Consent for Removal Action

On 11 May 2010, EPA filed the Administrative Settlement Agreement and Order on Consent for Removal Action, which was entered into voluntarily by the EPA, International Paper Company, and McGinnes Industrial Management Corporation. The Administrative Settlement Agreement and Order on Consent for Removal Action provided for the performance of a removal action (Time Critical Removal Action [TCRA]).

The EPA Action Memorandum required that the TCRA stabilize the northern impoundments to withstand forces sustained by the river, including a cover design that considered storm events with a return period of 100 years, and prevent direct human and benthic organism contact with waste materials. Elements of the selected TCRA included construction of a perimeter fence on the uplands to prevent unauthorized access; placement of warning signs around the perimeter of the northern impoundments and on the perimeter fence; design and implementation of an operations, monitoring, and maintenance plan; and installation of an armored cap with the following items:

- A stabilizing geotextile underlayment over the northern impoundment eastern cell
- Treatment through solidification of a portion (6,000 cubic yards in the upper 3 feet over 1.2 acres) of the western cell for construction equipment access
- An impervious geomembrane underlayment in the northern impoundment western cell
- A granular cover over the northwestern area of the northern impoundment western cell
- A granular cover above the geotextile and geomembrane in the northern impoundment western cell
- A granular cover above the geotextile in the northern impoundment eastern cell.

TCRA Armored Cap

Since its completion in July 2011, the armored cap has generally isolated and contained impacted material. The following cap deficiencies have been documented since the time of armored cap installation:

- July 2012: Approximately 200 square feet (ft^2) of geotextile exposed (armor materials had moved down slope)
- January 2013: Five areas deficient in cap thickness and/or have exposed geotextile
- December 2016: Approximately 550 ft^2 of cap missing or deficient in cover (no geotextile, paper mill waste exposed to the river, and a sediment concentration measured at 43,700 ng/kg $TEQ_{DF,M}$)
- February 2016: portions of eastern cell exposed (five areas, approximately 3 ft^2 each, of exposed geotextile)
- March 2016: additional portions of eastern cell deficient in armor cover thickness.

From December 2010 through July 2011, TCRA construction activities were completed at the Site.

General Area of the Time Critical Removal Action

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

The Operations, Monitoring, and Maintenance Plan identifies continuing obligations, including monitoring and maintenance, with respect to the TCRA. TCRA inspection events include: 1) visual inspection of the security fence, signage and the armored cap, 2) collection of topographic survey data for the portions of the armored cap that are located above the water surface, 3) collection of bathymetric survey data for the portions of the armored cap that are below the water surface, and 4) manual probing of armored cap thickness at areas identified by the topographic or bathymetry surveys as more than 6 inches lower in elevation than during the prior survey. Inspection and repair reports, as needed, are submitted to EPA. The Operation, Monitoring, and Maintenance Plan has been modified because the regular previous inspections failed to identify deficiencies in the cap.

Site Characteristics

The site is located in the estuarine portion of the lower San Jacinto River where the river begins to transition from a fluvial system to a deltaic plain.

Tropical weather systems in the region can have tremendous impacts on regional precipitation and hydrology along the Gulf Coast. Heavy precipitation events produce wide variations in the volume of discharge into and out of the San Jacinto River and may significantly affect variations in flow velocities,

Tropical Storms and Hurricanes

Between 1851 and 2004, 25 hurricanes have made landfall along the north Texas Gulf Coast, seven of which were major (Category 3 to 5) storms. Tropical Storm Allison, which hit the Texas Gulf Coast in June 2001, resulted in 5-day and 24-hour rainfall totals of 20 and 13 inches, respectively, in the Houston area, resulting in significant flooding. More recently, Hurricane Rita made landfall in September 2005 as a Category 3 storm with winds at 115 miles per hour. The storm surge caused extensive damage along the Louisiana and extreme southeastern Texas coasts. In September 2008, the eye of Hurricane Ike made landfall at the east end of Galveston Island. Ike made its landfall as a strong Category 2 hurricane, with Category 5-equivalent storm surge, and hurricane-force winds that extended 120 miles from the storm's center.

In October 1994, heavy rainfall occurred in southeast Texas resulting in the San Jacinto River Basin receiving 15 to 20 inches of rain during a week-long period. One of the largest measurements of stream flow ever obtained in Texas, 356,000 cubic feet per second (cfs), was made on the San Jacinto River near Sheldon on 19 October 1994 at a stage of 27 feet. During the measurement, velocities of water that exceeded 15 feet per second (about 10 miles per hour) were observed. Another storm occurring in 1940 had a river stage height of 31.5 feet at the same Sheldon location. The 100-year flood, which is defined as the peak stream flow having a one percent chance of being equaled or exceeded in any given year, was exceeded at 18 of 43 stations monitoring the area. For those stations where the 100-year-flood was exceeded, the flood was from 1.1 to 2.9 times the 100-year-flood.

The 1994 flooding caused major soil erosion and created water channels outside of the San Jacinto River bed. This flooding caused eight pipelines to rupture and 29 others were undermined at river crossings and in new channels created in the flood plain outside of the San Jacinto River boundaries. The largest new channel was cut through the Banana Bend oxbow just west of the Rio Villa Park subdivision, about 2½ miles northwest of the Site. This new channel was approximately 510-feet wide and 15-feet deep. A second major channel cut through Banana Bend just north of the channel through the oxbow. Both of these new channels were cut through areas where sand mining had been done before, as is the case in the vicinity of the Site. Sonar tests in a 130-foot section south of the I-10 Bridge located adjacent to the Site found about 10 to 12-feet of erosion from the bottom of the river bed.

Future flooding may be even more intense. According to the U.S. National Climate Assessment, flooding along rivers and other areas following heavy downpours and prolonged rains is exceeding the limits of flood protection infrastructure designed for historical conditions. Sea level rise, storm surge, and heavy downpours in combination with the pattern of continued development in coastal areas are increasing damage to U.S. infrastructure and are also increasing risks to ports and other installations.

sediment transport, suspended sediment loads, and water levels. Hurricane storm surges usually cause increases in water depth of 4 to 6 feet.

Flow rates and freshwater inputs into the San Jacinto River in the vicinity of the Site are partially controlled by the Lake Houston Dam, which is located about 16 river miles upstream of the northern impoundments. The average flow in the river is 2,200 cfs. Floods in the river occur primarily during tropical storms, hurricanes, or intense thunder storms. Extreme flood events have flow rates of 200,000 cfs or greater. Floods can cause water surface elevations to increase by 10 to 20 feet or more (relative to average flow conditions) and force the river out of its main channel. During low-flow conditions when current velocities

were dominated by tidal effects, maximum velocities were measured to be about 1 foot per second, with typical velocities of 0.5 foot per second or less during most of the tidal cycle.

Nature and Extent of Contamination – Waste Pits North of I-10

The waste pits north of I-10 contain elevated concentrations of dioxins and PCBs. The highest average concentrations of dioxin in surface and subsurface material north of I-10 occur in the northern impoundments (Figure 3). The maximum dioxin concentration in surface material (43,000 ng/kg) occurs in the northwest portion of the western cell of the impoundments. Cores within the western cell tend to show higher dioxin results throughout the upper core increments. Dioxin results generally decrease from their maximum with depth within a given core indicating that the peak concentrations have been located in the vertical dimension. The highest dioxin value in subsurface material (26,900 ng/kg) also occurs in the southern portion of the western cell. Average and maximum dioxin concentrations in surface and subsurface media outside of the northern impoundments are much lower than those within the northern impoundments.

The sample with the highest dioxin-like PCB concentration of 2.83 ng/kg was collected from within the northern impoundments. The second highest dioxin-like PCB concentration (2.23 ng/kg) was found west of the northern impoundments. Concentrations of PCBs in sediments were either significantly correlated with concentrations of dioxins or were non-detect.

Ground water sampling was conducted at three locations within the perimeter of the northern waste pits from each of two ground water bearing units below the waste pits. These ground water units contained brackish to saline ground water. Samples from five of the six wells did not detect any dioxin or furan. The sixth well screened in the uppermost ground water bearing unit below the waste pits did detect low level dioxin/furan at a concentration (2.64 pg/L) that is much lower than the maximum contaminant level of 30 pg/L for a drinking water zone. A water sample collected from within the waste pits contained 3,770 pg/L.

Nature and Extent of Contamination – Surface Water and Sediment

Surface water samples collected between 2002 and 2009 by the Texas Commission on Environmental Quality and the University of Houston showed elevated levels of dioxins near and downstream from the waste pits. Site sediment contains elevated concentrations of dioxins and furans, and PCBs. Dioxin and furan concentrations in sediments are highest within the perimeter of the northern impoundments than elsewhere at the Site. Within northern impoundments, dioxin results in sediments are highest in the western cell. Dioxin results in sediment outside of the northern impoundments are typically three to four orders of magnitude lower than those within the impoundments, even in areas directly adjacent to the perimeter. The attached map shows that there are elevated levels of dioxins in river sediments outside of the waste pits (Figure 3).

Outside of the northern impoundments perimeter, dioxin results in two surface sediment samples are above 100 ng/kg, at estimated concentrations of 121 ng/kg and 153 ng/kg. All other dioxin results in surface sediment outside of the northern impoundment perimeter are generally much lower. In the vicinity of the upland sand separation area (outside of the northern impoundments perimeter; Figure 2), two deep subsurface intervals (3 to 4 feet and 5 to 6 feet below mudline) have dioxin levels of 349 and 339 ng/kg, respectively, the highest dioxin measured outside the northern impoundment perimeter.

Dioxin-like PCB concentrations are highest in samples collected from within the northern impoundments perimeter, with the maximum value of 38.1 ng/kg from the 4- to 6-foot depth interval. The dioxin-like PCB concentrations in most surface and subsurface samples within the northern impoundment exceed 1 ng/kg, while all but two values outside of the northern impoundment are below 1 ng/kg. The two values outside of the northern impoundment exceeding 1 ng/kg are one surface (6.85 ng/kg) and one subsurface sample (1.58 ng/kg) location along the northwest portion of the peninsula south of I-10. The dioxin-like PCB concentrations do not significantly add to the total dioxin equivalent concentration.

A Chemical Fate and Transport Modeling Study was conducted during the RI/FS to simulate physical and chemical processes governing chemical fate and transport of dioxins at the Site. The fate and transport modeling was based on linked models that simulate hydrodynamics and sediment transport. The sediment transport portion of the model was used to simulate the erosion, deposition and transport of sediment in the San Jacinto River. Simulations were conducted to provide estimates of rates of natural recovery (i.e., reductions in surface sediment dioxin and furan concentrations over time) in various portions of the Model Study Area in the absence of any remedial action beyond the current Armored Cap. The modelling study found that the San Jacinto River at the Site is generally depositional. Based on the modeling, the estimated range of net sedimentation rates at the Site is 1.3 cm/year, ± 0.8 cm/year. This sedimentation rate is the average value over the entire cap, and it is important to keep in mind that the sedimentation rate was calculated by averaging the instances of both erosion and deposition in each grid cell over the simulated time period. The latter included long periods of fair (i.e. normal) weather, as well as high energy events including storms and floods. The positive value, i.e., 1.3 cm/year, indicates that there was, averaged over the cap, more deposition than erosion, albeit a small net Site-averaged quantity per year.

Principal Threat Wastes

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (NCP § 300.430(a)(1)(iii)(A)). In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile and which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site.

Elevated concentrations of dioxin has been detected at the Site in sediment (more than 43,000 ng/kg) and soil (more than 50,000 ng/kg). Dioxin is highly toxic and persistent in nature (will not breakdown for hundreds of years). With the regular occurrence of severe storms and flooding in the area, there is uncertainty that the waste material can be reliably contained over the long term and therefore should be considered highly mobile.

Because the dioxin waste in the northern impoundments and southern impoundment at the site is both highly toxic and highly mobile, it is considered a principal threat waste. The EPA considers material at the Site with more than 300 ng/kg of dioxin to be principle threat waste.

Nature and Extent of Contamination – Tissue

Tissue samples were collected from three Site fish collection areas (Figure 4):

- Downstream of I-10, referred to below as “downstream”
- In the area surrounding the impoundments north of I-10 and the upland sand separation area, referred to as “adjacent to the northern impoundments”
- Immediately upstream of the northern impoundments and upland separation area, referred to as “upstream.”

Data for blue crab, hardhead catfish, clams, and Gulf killifish are summarized in the tables below. The maximum detected values and highest mean values of dioxin and dioxin-like PCB generally were collected from the fish collection area adjacent to the northern impoundments.

This pattern of contaminant distribution was also observed for dioxin in hardhead catfish.

Summary of Tissue Results

	FCA 1		FCA 2		FCA 3		Background	
	Immediately Downstream		Adjacent to the Northern Impoundments		Immediately Upstream			
Chemical	Maximum Detected Value	Mean	Maximum Detected Value	Mean	Maximum Detected Value	Mean	Maximum Detected Value	Mean
Blue Crab								
Dioxin	1.91	0.739	0.558	0.23	0.271	0.146	0.639	0.157
Dioxin-like PCB	0.234	0.119	0.547	0.242	0.303	0.14	0.169	0.0907
Hardhead Catfish								
Dioxin	5.45	2.94	5.85	3.87	5.32	3.29	4.97	0.865
Dioxin-like PCB	2.27	1.28	2.03	1.28	2.79	1.36	0.804	0.48
Clams								
Dioxin	2.19	1.7	27.0	7.89	1.29	0.838	0.702	0.364
Dioxin-like PCB	0.271	0.22	1.9	0.502	0.436	0.366	0.283	0.181
Gulf Killifish								
Dioxin	--	0.102	10.1	2.70	0.43	0.404	0.307	0.13
Dioxin-like PCB	0.732	0.525	2.92	1.26	0.674	0.510	0.653	0.295

Note:
Results in nanograms per kilogram wet weight, nondetect results set at ½ the detection limit.
Cells with the highest observed values highlighted in blue.
FCA – Fish Collection Area
dioxin – 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity equivalent quotient
dioxin-like PCB – Polychlorinated biphenyl toxicity equivalent quotient

Nature and Extent of Contamination – Impoundment South of I-10

Dioxin concentrations in surface soil south of I-10 range from 1.35 ng/kg to 36.9 ng/kg (Figure 5). Substantially lower concentrations including the minimum dioxin concentration of 1.35 ng/kg are found at stations in close proximity to those that exceed the surface soil reference envelope value, or background, of 24.3 ng/kg indicating that these few slightly elevated dioxin concentrations are localized.

In subsurface soils from 6 to 24 inches, dioxin results range from 0.134 ng/kg to 303 ng/kg, with an average of 16.5 ng/kg. The second highest result in this depth interval (43.1 ng/kg) is much lower than the maximum. Dioxin results deeper than 2 feet range from 0.092 ng/kg to 50,100 ng/kg and average 743

ng/kg. The maximum core dioxin occurs at a depth of 6 to 8 feet from a sample collected in the southern part of the soil investigation south of I-10. The majority of the highest core dioxin concentrations occur between 6 and 12 feet deep, and are associated with stations located near the center of the peninsula south of I-10.

Ground water sampling was conducted at two locations outside of the southern impoundment; one was below the impoundment and the other was located downgradient to the west of the impoundment. The water in this area is brackish. Neither of these samples detected any dioxin or furan. Water samples collected from within the southern impoundment contained dioxin up to a maximum of 60.2 pg/L.

Resource Use

Current land use at the Site is primarily industrial and commercial use. Current land use surrounding the Site includes mixed residential and industrial uses to the west, and undeveloped or residential areas to the east and north. Immediately south of the Site is commercial/industrial land use. The future land use is not anticipated to be different from the current land use.

The area south of the Site is dominated by activities associated with the Houston Ship Channel, specifically industrial sites that are served by the barges and ocean-going vessels that use the Houston Ship Channel. From the Site north to Lake Houston, there is less industrialization along the river.

Commercial and recreational fishing activity occurs throughout Galveston Bay. The San Jacinto River along with nearby Upper Galveston Bay, Tabbs Bay, and the San Jacinto State Park have many points of public access. Through Texas Department of State Health Services (TDSHS) outreach activities, most of the people interviewed along the San Jacinto River, Houston Ship Channel, and Upper Galveston Bay have told TDSHS that they are fishing and/or crabbing for recreational purposes. However, some people do admit to consuming fish and/or crabs from these areas despite the fact that consumption of mollusks and shellfish (clams, mussels, and oysters) taken from public fresh waters is prohibited by TDSHS. Within public salt waters, these shellfish may be taken only from waters approved by TDSHS. TDSHS shellfish harvest maps designate approved or conditionally approved harvest areas. Waters near the Site are not included on these maps.

Although the Site is private land, nearby access points along the San Jacinto River allow for a variety of recreational activities including picnicking, swimming, nature walks, bird watching, wading, fishing, boating, water sports, and other shoreline uses. In the area to the south of the I-10 Bridge on the west side of the river, children and adults have been reported to play along the shoreline, wade in the water, and fish.

Scope and Role of Response Action

There is one operable unit for the Site. The response action proposed in this plan is intended to address the threats to human health and environment. The purpose of this response action is to implement a site-wide strategy that addresses the contaminated environmental media at the Site with the primary objectives of preventing human and ecological exposure to contaminants, and preventing or minimizing further migration of contaminants.

Summary of Site Risks

A Baseline Human Health Risk Assessment (BHHRA) and Baseline Ecological Risk Assessments (BERAs) were conducted to estimate the potential for current/future risk from exposure to contaminants from the Site. The BHHRA and BERAs were conducted to determine potential pathways by which people (human receptors) or animals (ecological receptors) could be exposed to upland or aquatic contamination in sediment, soil, water, or biota; the amount of contamination receptors of concern may be exposed to; and the toxicity of those contaminants if no action were taken to address contamination at the Site.

The risk assessments were conducted on the baseline conditions that existed before the installation of the TCRA armored cap over the northern waste pits that was completed during a removal action. This temporary cap was built to stabilize the northern waste pits and prevent direct human exposures until a permanent remedy could be selected for the Site. These assessments provide the basis for taking action and identify the contaminants and exposure pathways that need to be addressed by the remedial action.

It is EPA's current judgement that the Preferred Remedy identified in this Proposed Plan, or one of the other alternatives considered in the Proposed Plan, is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

What is Risk and How is it Calculated?

A Superfund human health risk assessment estimates the "baseline risk." This is an estimate of the likelihood of health problems occurring if no cleanup action was taken at a site. To estimate the baseline risk at a site, a four-step process is used:

Step 1: Analyze Contamination
Step 2: Estimate Exposure
Step 3: Assess Potential Health Dangers
Step 4: Characterize Site Risk

In Step 1, the concentrations of contaminants found at a site are examined as well as past scientific studies that demonstrate the effects these contaminants may have on people (or animals, when human studies are unavailable). Comparisons between site-specific concentrations and concentrations reported in past studies help determine which contaminants are most likely to pose the greatest threat to human health.

In Step 2, the different ways that people might be exposed to the contaminants identified in Step 1, the concentrations that people might be exposed to, and the potential frequency and duration of exposure are considered. Using this information, a "reasonable maximum exposure" scenario is calculated, which portrays the highest level of human exposure that could reasonably be expected to occur.

In Step 3, the information from Step 2 is combined with information on the toxicity of each chemical to assess potential health risks. Two types of risk, cancer risk and non-cancer risk, are considered. The likelihood of any kind of cancer resulting from a site is generally expressed as an upper-bound probability; for example, a "1 in 10,000 chance." In other words, for every 10,000 people that could be exposed, one extra cancer may occur as a result of exposure to site contaminants. An extra cancer case means that one more person could get cancer than would normally be expected to from all other causes. For non-cancer risks, a hazard index (HI) is calculated. The key concept here is that a "threshold level" exists below which non-cancer health effects are no longer predicted.

In Step 4, it is determined if site risks are great enough to cause health problems for people at or near the site. The results of the three previous steps are combined, evaluated, and summarized. The potential risks from the individual chemicals are added up. If cancer or non-cancer risks are found to be unacceptable, the contributing chemicals are then identified as contaminants of concern (COCs). For cumulative cancer risks, the EPA has determined increased cancer risk in excess of 10^{-4} (1 in 10,000) is unacceptable. The risk range of 10^{-6} to 10^{-4} may be evaluated to determine whether risk is acceptable for future site conditions (such as land use and potential users). For cumulative non-cancer risks, the EPA has established an HI of less than 1.0 as acceptable.

Human Health Risk

The BHHRA identified non-cancer hazards greater than one for some recreational fisher exposure scenarios (direct exposure to beach areas identified and the ingestion of catfish, clam, or crab from fishing areas identified), for some recreational visitor exposure scenarios (direct exposure to the beach area identified), and for some future construction worker exposure scenarios. The tables below provide a summary of Site related non-cancer hazard quotients above one. Hazard quotients greater than one

indicate the potential of contaminants of concern (e.g. dioxin) to exert adverse health effects to those that are exposed in the manner specified in the tables. There were no cancer risks above the upper limit of EPA's target cancer risk range ($1x10^{-4}$) for all areas identified in the BHHRA except for Beach Area E, which had an excess cancer risk of 6.6×10^{-4} for a recreational fisher exposed through ingestion and dermal contact with sediment. The basis for action at the Site are the unacceptable hazards to the recreational fisher (Hazard Index 65), to the recreational visitor (Hazard Index 66), and to the construction worker (Hazard Index 46). The three tables below provide more information on these hazards. For the recreational fisher (Figures 4 and 6) and the recreational visitor (Figure 7), risk assessments were done for areas both north and south of I-10. For the construction worker, the risk assessment applies to the area south of I-10 (Figure 8).

Non-Cancer Hazards for a Recreational Fisher

Chemical	Primary Target Organ	Non-Cancer Hazard Quotient			Exposure Route Total
		Incidental Ingestion of Sediment	Dermal Contact with Sediment	Consumption of Fish or Shellfish	
Scenario 1A: Direct Exposure Beach Area A; Ingestion of Catfish from Fish Collection Area 2/3					
Dioxins and dioxin-like PCBs	Reproductive/Developmental	0.0006	0.0016	1.8	1.8
Scenario 2A: Direct Exposure Beach Area B/C; Ingestion of Catfish from Fish Collection Area 2/3					
Dioxins and dioxin-like PCBs	Reproductive/Developmental	0.0081	0.0229	1.8	1.8
Scenario 3A: Direct Exposure Beach Area E; Ingestion of Catfish from Fish Collection Area 2/3					
Dioxins and dioxin-like PCBs	Reproductive/Developmental	16	47	1.8	65
Scenario 3B: Direct Exposure Beach Area E; Ingestion of Clam from Fish Collection Area 2					
Dioxins and dioxin-like PCBs	Reproductive/Developmental	16	47	0.27	64
Scenario 3C: Direct Exposure Beach Area E; Ingestion of Crab from Fish Collection Area 2/3					
Dioxins and dioxin-like PCBs	Reproductive/Developmental	16	47	0.008	63
Scenario 4A: Direct Exposure Beach Area D; Ingestion of Catfish from Fish Collection Area 1					
Dioxins and dioxin-like PCBs	Reproductive/Developmental	0.0027	0.0076	1.8	1.8
Note: PCBs – Polychlorinated Biphenyls Dioxins – see Glossary					

Non-Cancer Hazards for a Recreational Visitor

Chemical	Primary Target Organ	Non-Cancer Hazard Quotient				Total
		Incidental Ingestion of Sediment	Incidental Ingestion of Soil	Dermal Contact with Sediment	Dermal Contact with Soil	
Scenario 3: Direct Exposure Beach Area E						
Dioxin	Reproductive/ Developmental	17	0.03	49	0.0021	66
Note: Dioxin – 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity equivalent quotient						

Non-Cancer Hazards for a Future Construction Worker

Chemical	Primary Target Organ	Non-Cancer Hazard Quotient		Total
		Incidental Ingestion of Soil	Dermal Contact with Soil	
Scenario DS-1: Direct Exposure to Surface and Subsurface Soils				
Dioxin	Reproductive/Developmental	9.6	0.49	10
Scenario DS-2: Direct Exposure to Surface and Subsurface Soils				
Dioxin	Reproductive/Developmental	44	2.2	46
Scenario DS-4: Direct Exposure to Surface and Subsurface Soils				

Dioxin	Reproductive/Developmental	32	1.6	34
Scenario DS-5: Direct Exposure to Surface and Subsurface Soils				
Dioxin	Reproductive/Developmental	2.2	0.11	2.3
Note: Dioxin – 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity equivalent quotient				

Ecological Risk

Baseline risks to ecological receptors associated with the wastes in the impoundments north of I-10 are the result of exposures to dioxins localized to the immediate vicinity of the impoundments. Baseline ecological risks include reproductive risks to mollusks from to dioxin, but primarily in the area that surrounds the former waste impoundments north of I-10, and low risks of reproductive effects in individual mollusks in sediments adjacent to the upland sand separation area, but not to populations of mollusks. Baseline risks include moderate risks to individual birds like the killdeer or spotted sandpiper whose foraging area could regularly include the shoreline adjacent to the impoundments north of I-10, but low risk to populations because of the low to moderate probability that individual exposures reach effects levels. Baseline risks include risks to individual small mammals with home ranges that include areas adjacent to the impoundments such as the marsh rice rat, but low to negligible risks to small mammal populations because of the moderate probability that exposures will reach levels associated with reproductive effects in individuals, and because small mammals reproduce rapidly.

Baseline risks to benthic macroinvertebrate communities and populations of fish, birds, mammals, and reptiles resulting from the presence of metals, bis(2-ethylhexyl) phthalate, PCBs, carbazole, and phenol on the Site are negligible. Risks to fish populations from all chemicals of potential concern are negligible. There are negligible risks to populations of wading birds represented by the great blue heron, and to populations of diving birds like the neotropic cormorant. There are negligible risks to populations of terrestrial mammals such as the raccoon. There are low to negligible risks to individual terrestrial insectivorous birds like the killdeer from exposure to zinc, and negligible risks to populations of such birds. Although the upper bound of estimated daily intakes of zinc by individual killdeer is about equal to conservative effects thresholds, the exposure estimate is influenced by the use of generic models to estimate zinc concentrations in the foods of the killdeer, and this model likely overestimates ingested tissue concentrations, resulting in overestimates of exposure and risk. The highest exposures of killdeer to zinc occur outside of the northern impoundment perimeter, and background exposures less than 30 percent lower than on the Site. In addition, the low probability of individual exposures exceeding effects levels indicates low risk to populations. There are also low to negligible risks to individual terrestrial insectivorous birds from exposure to dioxins. The BERAs identified risk to ecological receptors as summarized in the tables below.

Ecological Risks

Receptor of Concern	Feeding Guild	Contaminant of Concern	Baseline Risk Identified
Benthic Macroinvertebrates			
Mollusks	Filter feeders	2,3,7,8-TCDD	Reproductive risks to mollusks (primarily in the area which surrounds the waste impoundments)
Individual mollusks	Filter feeders	2,3,7,8-TCDD	Low risks of reproductive effects (sediments adjacent to the upland sand separation area)
Birds			
Spotted sandpiper	Invertivore (probing)	Dioxin	Moderate risks to individual birds, low risk to populations
Killdeer	Invertivore (terrestrial)	Dioxin	Moderate risks to individual birds, low risk to populations

Mammals			
Marsh rice rat	Omnivore	Dioxin	Risk to individual small mammals with home ranges that include areas adjacent to the impoundments; low to negligible risk to populations

Note:
2,3,7,8-TCDD – 2,3,7,8-tetrachlorodibenzo-p-dioxin
Dioxin – toxicity equivalent quotient for 2,3,7,8-tetrachlorodibenzo-p-dioxin calculated using toxicity equivalent factors for mammals

Remedial Action Objectives

1) Eliminate releases of dioxins and furans from the former waste impoundments to sediments and surface water of the San Jacinto River.

2) Reduce human exposure to dioxins and furans from consumption of fish by remediating paper mill waste and sediments affected by paper mill waste to appropriate cleanup levels.

3) Reduce human exposure to dioxins and furans from direct contact with paper mill waste, soil, and sediment by remediating affected media to appropriate cleanup levels.

4) Reduce exposures of benthic macroinvertebrates to paper mill waste-derived dioxins and furans by remediating sediment to appropriate cleanup levels.

Remedial Action Objectives and Preliminary Remediation Levels

Remedial Action Objectives (RAOs) describe what the proposed site cleanup is expected to accomplish.

According to the NCP, 40 CFR §300.430(a)(1)(i), the "national goal of the remedy selection process is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste." Based on information relating to types of contaminants, environmental media of concern, and potential exposure pathways, site specific RAOs were developed. The RAOs developed consider the current and reasonably anticipated future land use including the use for industrial applications and by recreational fishers. Concentrations of PCBs in sediments were either significantly correlated with concentrations of dioxins indicating that remediation for dioxins and furans will also address the PCBs, or were generally below detection limits. Therefore, no RAO was developed for PCBs.

While the BHHRA considered subsistence fisher populations, none have been identified at the Site and therefore this receptor is not considered to be consistent with the current or future land use. The Texas Department of State and Health Services (DSHS) provided the following information to strengthen the explanation of how it was determined there was no significant subsistence fishing at the site.

> *The USEPA suggests that, along with ethnic characteristics and cultural practices of an area's population, the poverty rate could contribute to any determination of the rate of subsistence fishing in an area. The USEPA and the DSHS find it is important to consider subsistence fishing to occur at any water body because subsistence fishers (as well as recreational anglers and certain tribal and ethnic groups) usually consume more locally caught fish than the general population. These groups sometimes harvest fish or shellfish from the same water body over many years to supplement caloric*

and protein intake. People, who routinely eat fish from chemically contaminated water bodies or those who eat large quantities of fish from the same waters, could increase their risk of adverse health effects. The USEPA suggests that states assume that at least 10% of licensed fishers in any area are subsistence fishers. Subsistence fishing, while not explicitly documented by the DSHS, likely occurs in Texas. The DSHS assumes the rate of subsistence fishing to be similar to that estimated by the USEPA.

In the DSHS Public Health Assessment that was released in October 2012, one of the exposure scenarios was that of a subsistence fishermen. This was incorporated to account for the potential exposure pathway to children and adults that may be subsistence fishermen and consume fish caught from areas surrounding the SJRWP. The scenario used was:

Adults who fish 260 days/year for 30 years and children of subsistence fishers who are exposed from age 3 – 50 (47 years).

Through DSHS outreach activities, most of the people interviewed along the San Jacinto River, Houston Ship Channel, and Upper Galveston Bay have told DSHS that they are fishing and/or crabbing for recreational purposes; however, some people do admit to consuming fish and/or crabs from these areas. One could assume that a small percentage of people found fishing in these areas could potentially be subsistence fishers but don't admit it."

The following Preliminary Remediation Goals (PRGs) provide numerical criteria that will be used to measure the progress in meeting the RAOs. PRGs are acceptable exposure levels (i.e., contaminant concentration levels) that are protective of human health and the environment, and are developed considering applicable, relevant, and appropriate requirements (ARARs), as specified in the NCP. Site PRGs are presented below:

- Dioxin in river sediment – 30 ng/kg (recreational fisher).
- Dioxin in paper mill waste source areas – 200 ng/kg (recreational visitor).
- Dioxin in subsurface soil – 240 ng/kg (Southern Impoundment construction worker).
- Texas Surface Water Quality Standard for Dioxins/Furans – 7.97×10^{-8} µg/L (as TCDD equivalents). [30 TAC §307.6(d)(a)(A) and (B) and §307.10]. This standard was updated by TCEQ in 2014 and approved by EPA to base the dioxin standard on water column criteria. The standard was calculated based on an oral cancer slope factor of 156,000 found in in the EPA 2002 National Recommended Water Quality Criteria Matrix.

The river sediment PRG of 30 ng/kg was developed for the Site based on protecting human health of the most vulnerable potentially exposed group or individual of the community. In this case a recreational child fisher was assumed to get exposed to contaminated sediment through incidental ingestion, dermal contact, and from the ingestion of fish/shellfish contaminated with Site sediment. The 30 ng/kg is associated with a non-cancer Hazard Index of one with the understanding that by protecting at a Hazard Index of one will also be protecting for cancer effects near the middle (2.1×10^{-5}) of the EPA's generally acceptable cancer risk range.

For the river areas outside of the armor cap, the surface area – weighted average concentration (SWAC) for Fish Collection Area 1 located just south of the waste pits (Figure 4) is 16.1 ng/kg, and for Fish Collection Area 2/3 located adjacent to and upstream of the waste pits is 11.2 ng/kg. Because the average

dioxin concentrations both upstream and downstream of the waste pits are less than the 30 ng/kg PRG for river sediment, remediation of the river sediment, with the exception of the source areas described below, is not required.

The 200 ng/kg PRG for the source areas is associated with a non-cancer Hazard Index of one. In this case a recreational child fisher was assumed to get exposed to contaminated sediment. The source areas include the waste pits and the sand separation area (Figure 2).

Commented [KG1]: In the paragraph above you say 200 ng/Kg is for recreational visitor. Although the recreational child fisher also happen to have 200 ng/Kg as a cleanup level too. But to be consistent you need to change it to "recreational visitor".

The 240 ng/kg PRG applies to soil the Southern Impoundment (Figure 8) and is associated with a non-cancer Hazard Index of one. In this case a construction worker was assumed to get exposed to contaminated sub-soils in the area during construction activities. The surface soil in this area is less than 50 ng/kg.

The non-site related background sediment concentration is less than 7.2 ng/kg dioxin, well below the acceptable river sediment PRG (30 ng/kg) adopted for the Site.

There are no PRGs for fish tissue because the required sediment cleanup measures at the Site will reduce contaminant concentrations in tissue, but these concentrations will continue to be affected by factors outside the scope of the CERCLA Site cleanup, including upstream and downstream dioxin inputs from other sources. Measuring trends against target tissue concentrations is useful for assessing risk reduction and for risk communication, but tissue PRGs are not required to evaluate these trends.

It is anticipated that the 200 ng/kg dioxin PRG for the source areas, as well as the 30 ng/kg dioxin PRG in river sediment, will be achieved relatively soon after construction of the Preferred Alternative (Alternative 6N) is completed, or approximately 2 years after construction begins. The 240 ng/kg dioxin PRG for the Southern Impoundment will be achieved when construction of the Preferred Alternative there (Alternative 4S) is completed, or approximately 7 months after construction begins.

Summary of Remedial Alternatives

The FS identified and screened possible response actions and remedial technologies applicable to the Site. Following the screening process, remedial alternatives were developed to address the area north of I-10 and the area south of I-10. Alternatives that address the area north of I-10 and aquatic environment include the letter "N" in the title (e.g., 1N, 2N), and alternatives that address the area south of I-10 include the letter "S" in the title (e.g., 1S, 2S).

Alternatives for the San Jacinto River and Area North of I-10:

Alternative 1N – Armored Cap and Ongoing Operations, Inspection, and Maintenance (No Further Action)

Estimated Maintenance Cost (e.g., inspection, maintenance, 5-year reviews): $0.5 million
Estimated Total Present Worth Cost: $0.5 million
Estimated Construction Time: Construction complete

Under this alternative, the controls installed as part of the TCRA and as a result of the TCRA reassessment would remain in place and no additional remedial action would be implemented. Treatment through solidification of a portion of the paper mill waste material was completed to aid construction of the cap.

However, this alternative has no further provision for treatment or removal of the Principle Threat Waste. Approximately 6,000 cubic yards in the upper 3 feet over 1.2 acres of the western cell was treated with 8% Portland Cement to allow access for construction. This alternative includes ongoing operations, inspection, and maintenance of the armored cap, which includes inspection and periodic maintenance, and EPA 5-year reviews as required under the NCP in 40 CFR 300.430 (f)(iv)(2). The total present costs for this and all other alternatives are calculated using a 30 year timeframe and a 7% discount rate.

Alternative 2N – Armored Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery

Estimated Maintenance Cost: $2.0 million
Estimated Total Present Worth Cost: $2.0 million
Estimated Construction Time: Construction complete

This alternative includes all of the elements discussed under Alternative 1N, plus institutional and engineering controls, ground water monitoring, and Monitored Natural Recovery (MNR). MNR would be used to achieve the PRG for sediment in the sand separation area and the Texas Surface Water Quality Standard in the San Jacinto River. Hydrodynamic and sediment transport modeling of the San Jacinto River in the vicinity of the Site determined that there is a net deposition of sediment that will support MNR. Further, approximately two feet of sediment deposition found over the toe of the cap in the northwest area during an EPA Dive Team inspection of the cap also supports the depositional nature of the area.

This Alternative 2N this would not result in treatment other than the solidification for construction of the Principle Threat Waste, which is defined as Site material containing dioxin greater than 300 ng/kg.

There are other sources of dioxin to the San Jacinto River upstream from the Site, however, these sources are characterized by different "fingerprint" than the dioxin in the waste pits. The dioxin upstream of the Site contains a relatively large amount of hepta-dioxin (has 6 chlorine atoms per dioxin molecule) and very little tetra-dioxin (has 4 chlorine atoms per dioxin molecule) (Figure 9). Conversely, the waste pit dioxin contains a relatively large amount of tetra-dioxin and very little hepta-dioxin (Figure 10). The sediment upstream from the Site has a dioxin concentration that is less than the background concentration of 7.2 ng/kg, as well having a different sources ass concentration that is also less than 7.2 ng/kg dioxin.

Institutional Controls

Institutional controls are non-engineered instruments such as administrative and legal controls that help minimize the potential for human exposure to contamination and protect the integrity of a remedy by limiting land or resource use.

Engineering Controls

Engineering controls are physical measures such as fencing or signage that are used to limit access to contaminated areas or areas that may pose a physical hazard.

Monitored Natural Recovery

MNR is a technology in which contaminant concentrations are monitored with no other remedial actions taken to address contamination. MNR assesses the natural attenuation of contaminants by physical, chemical, and biological processes.

Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place. Under this remedial alternative, the following institutional and engineering controls would be implemented:

- Restrictions on dredging and anchoring would be established to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment under the residuals

cover layers and near the upland sand separation area where one location exists with dioxin concentrations exceeding the sediment cleanup goal.

- Alert property owners of the presence of subsurface materials exceeding Remediation Levels.
- Public notices and signage around the perimeter of the TCRA site would be maintained or provided, as appropriate.
- The institutional controls will be implemented and maintained by the PRPs with oversight by EPA and TCEQ.
- As a result of the long term persistence of dioxin, it is anticipated that the institutional controls will be essentially permanent measures.

A periodic sampling and analytical program would also be implemented to monitor the progress of natural recovery.

Alternative 3N – Permanent Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery

Estimated Capital Cost: $1.77 million
Estimated In-Direct & Post Construction Cost: $2.38 million
Estimated Total Present Worth Cost: $4.1 million
Estimated Construction Time: 2 months

This alternative includes the actions described under Alternative 2N plus additional improvements to the TCRA armored cap to create a permanent cap. The improvements use a higher factor of safety of 1.5 for sizing the armor stone, and include flattening submerged slopes from 2 horizontal to 1 vertical (2H:1V) to 3H:1V and flattening the slopes in the surf zone from 3H:1V to 5 horizontal to 1 vertical (5H:1V). In addition, the Permanent Cap uses larger rock sized for the "No Displacement" design scenario, which is more conservative than the "Minor Displacement" scenario used in the Armored Cap's design. This alternative will increase the long-term stability of the armored cap compared to Alternatives 1N and 2N. However, the enhanced cap under Alternative 3N is expected to experience 80% erosion of the cap during a severe storm as determined by the Corps of Engineers' report (Appendix A of the Feasibility Study), Cost estimates for this alternative also include additional measures to protect the permanent cap from potential vessel traffic in the form of a protective perimeter barrier and could include construction of a 5-foot high submerged rock berm outside the perimeter of the permanent cap, in areas where vessels could potentially impact the cap. MNR would be used to achieve the PRG for sediment in the sand separation area and the Texas Surface Water Quality Standard in the San Jacinto River.

This Alternative 3N this would not result in treatment other than the solidification for construction of the Principle Threat Waste, which is defined as Site material containing dioxin greater than 300 ng/kg.

Improvements to the armored cap would involve flattening the slopes of the existing cap by adding additional armor rock material to enhance the effectiveness and permanence by increasing the degree of safety. The permanent cap would include 1.5 for sizing the armor stone, flattening submerged slopes from 2 horizontal to 1 vertical (2H:1V) to 3H:1V, and flattening the slopes in the surf zone from 3H:1V to 5H:1V. The permanent cap would use larger rock sized for the "No Displacement" design scenario, which is more conservative than the "Minor Displacement" scenario used in the armored cap's design. Upon completion,

the Permanent Cap would be constructed to a standard that exceeds EPA and USACE design guidance, and meets or exceeds the recommended enhancements suggested by USACE in their 2013 evaluation. Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place. Institutional controls would be implemented to place restrictions on dredging and anchoring to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment near the upland sand separation area where one location exists with dioxin concentrations exceeding the 200 ng/kg sediment cleanup goal.

Alternative 3aN – Enhanced Permanent Cap, Protective Pilings, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery

Estimated Capital Cost: $19.7 million
Estimated In-Direct & Post Construction Cost: $5.1 million
Estimated Total Present Worth Cost: $24.8 million
Estimated Construction Time: 15 months

The Corps of Engineers determined that the cap considered for Alternative 3N may experience 80% erosion of the armor cap (Appendix A of the Feasibility Study), and substantial erosion of the underlying paper mill waste material in a future severe storm. This alternative, 3aN, includes the actions described under Alternative 3N plus additional enhancements to the TCRA armored cap recommended by the Corps of Engineers.to create a permanent cap with increased long-term stability.

The additional cap enhancements added for this alternative include pre-stressed concrete or concrete filled steel pipe pilings placed 30 feet apart around the perimeter of the cap to protect from barge strikes. The spacing is designed to catch a typical barge, which is 35 feet wide. An additional armor stone cap with a thickness of at least 24 inches would be placed over the armor cap described under Alternative 3N. The armor stone would have a median diameter of 15 inches. This additional armor stone would cover 13.4 acres of the 17.1 acre armored cap. Also, a course gravel filter layer would be placed on 1.5 acres of the Northwest Area where there is currently no geotextile under the armor cap. The actual scope and design of the cap enhancements would be determined in the Remedial Design

This Alternative 3aN this would not result in treatment of the Principle Threat Waste, which is defined as Site material containing dioxin greater than 300 ng/kg, with the exception of the solidification for construction of the western cell of the original cap

Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place. Institutional controls would be implemented to place restrictions on dredging and anchoring to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment near the upland sand separation area where one location exists with dioxin concentrations exceeding the 200 ng/kg sediment cleanup goal.

Alternative 4N – Partial Solidification/Stabilization, Permanent Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery

Estimated Capital Cost: $11.13 million
Estimated In-Direct & Post Construction Cost: $3.74 million
Estimated Total Present Worth Cost: $14.8 million
Estimated Construction Time: 17 months

This remedial alternative provides for solidification and stabilization of the most highly contaminated material. A dioxin and furan value that exceeds 13,000 ng/kg dioxin was used to define the most highly contaminated material; however, this would not result in treatment of all of the Principle Threat Waste, which is defined as Site material containing dioxin greater than 300 ng/kg. Under this alternative, 3.6 acres of the armor cap would be removed and about 52,000 cubic yards of materials beneath the cap exceeding 13,000 ng/kg dioxin would undergo solidification and stabilization. The type of amendments would be determined during the Remedial Design. The extent of the area for partial solidification and stabilization is the western cell and a portion of the eastern cell that is currently covered by the armored cap. The maximum depth of solidification and stabilization in the western cell would be to approximately 10-feet below the current base of the armored cap and on average approximately 5-feet below the current base of the armored cap in the eastern cell and northwestern area.

Solidification and stabilization treatment could be accomplished using large-diameter augers or conventional excavators. Before treating the sediment, the affected portions of the armored cap armor rock would need to be removed and stockpiled for reuse, if possible, or washed to remove adhering sediment and disposed in an appropriate upland facility. The geotextile and geomembrane would need to be removed and disposed of as contaminated debris. Solidification and stabilization reagents, such as Portland cement, would be mixed with sediment, as needed, to treat the sediment *in situ*. Submerged areas to be stabilized would need to be isolated from the surface water with sheet piling and mostly dewatered prior to mixing with treatment reagents using conventional or long reach excavators.

Finally, the permanent cap, as described in Alternative 3N, would be constructed, including replacement of the armor rock layer geomembrane and geotextile over the solidification and stabilization footprint; and the measures described under Alternative 3N to protect the permanent cap from vessel traffic would be implemented. MNR would be used to achieve the PRG for sediment in the sand separation area and the Texas Surface Water Quality Standard in the San Jacinto River. Institutional controls would be implemented to place restrictions on dredging and anchoring to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment near the upland sand separation area where one location exists with dioxin concentrations exceeding the sediment cleanup goal. Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place.

The estimated footprint of this alternative is approximately 2.6 acres in the western cell and 1.0 acre of submerged sediment spanning the eastern cell and the northwestern area. Based on the horizontal and vertical limits identified for this alternative, a total of approximately 52,000 cubic yards of soil and sediment would be treated.

Alternative 5N – Partial Removal, Permanent Cap, Institutional Controls, and Monitored Natural Recovery

Estimated Capital Cost: $24.86 million
Estimated In-Direct & Post Construction Cost: $4.94 million
Estimated Total Present Worth Cost: $29.8 million
Estimated Construction Time: 13 months

This remedial alternative provides for removal and offsite disposal of the most highly contaminated material. A dioxin and furan value that exceeds 13,000 ng/kg dioxin was used to define the most highly contaminated material; however, this would not result in removal or treatment of all of the Principle Threat Waste, which is defined as Site material containing dioxin greater than 300 ng/kg. Under this alternative,

3.6 acres of the armor cap would be removed and about 52,000 cubic yards of materials beneath the cap exceeding 13,000 ng/kg dioxin would be removed. The lateral and vertical extent and volume of sediment removed under this alternative is the same as the sediment to be treated as described in the previous section for alternative 4N. Construction of a permanent cap, institutional controls, and MNR, as described in Alternative 3N, are also included in this remedial alternative.

To mitigate potential water quality issues, submerged areas would need to be isolated using berms, sheet piles, and/or turbidity barrier/silt curtains prior to excavating sediment. Upland areas would not need to be isolated with sheet piling, but the excavation would require continuous dewatering and may need to be timed to try to avoid high water and times of year when storms are most likely.

Excavated sediment would be dewatered or solidified for disposal at an off-site permitted facility. Effluent from excavated sediment dewatering would need to be handled appropriately, potentially including treatment prior to disposal. Following completion of the excavation, the work area would be backfilled to replace the excavated sediment and then the permanent cap would be constructed, including replacing the armor rock layer above the excavation footprint and the geomembrane and geotextile layers. Institutional controls would be implemented to place restrictions on dredging and anchoring to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment near the upland sand separation area where one location exists with dioxin concentrations exceeding the sediment cleanup goal. Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place.

Alternative 5aN - Partial Removal of Materials Exceeding Cleanup Levels, Permanent Cap, Institutional Controls, and Monitored Natural Recovery

Estimated Capital Cost: $60.38 million
Estimated In-Direct & Post Construction Cost: $9.21 million
Estimated Total Present Worth Cost: $69.6 million
Estimated Construction Time: 19 months

For this alternative, the removal cleanup goal for a recreational visitor (200 ng/kg dioxin) was considered for the area within the armored cap, which is either above the water or where the water depth is 10 feet or less. As an additional criterion, locations exceeding 13,000 ng/kg dioxin are also removed regardless of water depth; however, all samples exceeding 13,000 ng/kg dioxin are located in areas where the water depth is 10 feet or less. This alternative entails removal of approximately 137,600 cubic yards of sediment from the waste pits.

As with Alternatives 4N and 5N, the existing armored cap (consisting of cap rock, geomembrane, and geotextile) would need to be removed prior to beginning excavation work.

This alternative also includes an engineered barrier to manage water quality during construction. In shallow water areas (water depths up to approximately 3 feet), this barrier would be constructed as an earthen berm, extending to an elevation at least 2 feet above the high water elevation in consideration of wind-generated waves and vessel wakes.

Work would be conducted in the wet. Excavated sediment would be offloaded, dewatered, and stabilized at a dedicated offloading location, as necessary, to eliminate free liquids for transportation and disposal. Following removal of impacted sediment, the area from which sediments are removed would be covered with a residuals management layer of clean cover material.

In the deeper water areas of the waste pits where removal is not conducted, the existing armored cap would be maintained. MNR would be used to achieve the PRG for sediment in the sand separation area. Institutional controls would be implemented to place restrictions on dredging and anchoring to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment near the upland sand separation area where one location exists with dioxin concentrations exceeding the sediment cleanup goal. Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place.

Alternative 6N - Full Removal of Materials Exceeding Cleanup Levels and Institutional Controls

Estimated Capital Cost: $89.6 million
Estimated In-Direct & Post Construction Cost: $11.3 million
Estimated Total Present Worth Cost: $101 million
Estimated Construction Time: 19 months

This alternative involves the removal of all material that exceeds the PRG of 200 ng/kg. This would involve removal of the majority of the existing armored cap and the removal of 200,100 cubic yards of material. Alternative 6N includes the provisions for Best Management Practices (BMPs) recommended by the Corps of Engineers as described in their report (referenced as Alternative 6N* in Appendix A of the Feasibility Study).

The full removal alternative will utilize BMPs to reduce and control the re-suspension of sediment. While the BMPs identified below were recommended by the Corps of Engineers and were used for costing purposes, the final use and design of BMPs will be determined during the Remedial Design. The removal will be completed in stages or sections as appropriate to limit the exposure of the uncovered sections of the waste pits to potential storms. Raised berms, sheet piles, and silt curtains in addition to dewatering and removal in the dry will be used to reduce the re-suspension and spreading to the removed material. The berms would be armored on both sides with armor material removed from the areas that have geotextile present. Approximately three-fourths of the material will be excavated in the dry behind sheet pile walls. An excavation dewatering and water treatment system will operate on any day of excavation. Residual concentrations of contaminants following excavation and removal will be covered by at least two layers of clean fill to limit intermixing of residual material with the clean fill. As with the partial removal alternatives, cap rock, geomembrane, and geotextile from the existing armored cap, which currently isolates and contains impacted material, would be removed prior to beginning excavation. Removal of submerged sediments in the Northwest area will include isolation of the work area with berms/sheet piles. Excavated sediment would be dewatered (decanted) and stabilized by addition of portland cement or other additive at the offloading location, as necessary, to eliminate free liquids for transportation and disposal. Some operations, such as water treatment, may be barge mounted. Following removal of impacted sediment, the area from which sediments are removed will be covered with at least two residuals management layers of clean sediment to reduce intermixing. In the Northwest area only, armoring of the residuals cover layers will include 15 inch median diameter stone. The protective berms will be left in place after construction to provide a barrier, limiting barge and boat traffic over the site. Institutional controls will be used to prevent disturbance of the sediment residuals below the residual cover layers in the remediated areas that may exceed the cleanup level.

This alternative entails removal of approximately 200,100 cubic yards of sediment from the waste pits footprint and the area near the upland sand separation area, which would require a relatively large offloading and sediment processing facility to efficiently accomplish the work, which would require barge

unloading, sediment re-handling, dewatering, stockpiling, transloading, and shipping to the offsite landfill facility. Additional activities would include management and disposal of dewatering effluent, including treatment if necessary. Soil that is removed would be transported in compliance with applicable requirements and permanently managed in a permitted landfill cleared by the EPA's regional offsite rule contact. It is anticipated that the material to be disposed of will be classified as a Class 1 non-hazardous industrial waste, and that no Land Disposal Restrictions will apply because the material is neither a listed nor a characteristic hazardous waste, although it is a hazardous substance under CERCLA. The material will require treatment to remove any free liquids.

Alternatives for the Former Southern Impoundment:

Alternative 1S – No Further Action

Estimated Capital Cost: $0
Estimated Post Construction Cost: $143,000
Estimated Total Present Worth Cost: $143,000
Estimated Construction Time: None

Under this remedial alternative for the area of investigation south of I-10, impacted soil would remain in place and no steps would be taken to alert future landowners or construction workers of the presence, at depth, of dioxin concentrations exceeding cleanup goals. The estimated cost for this alternative includes the cost of future EPA five-year reviews.

Alternative 2S – Institutional Controls and Ground Water Monitoring

Estimated Capital Cost: $65,000
Estimated Post Construction Cost: $959,000
Estimated Total Present Worth Cost: $1.02 million
Estimated Construction Time: None

This alternative would apply to locations in the area south of I-10 where the average dioxin concentration in the upper 10 feet of soil below grade exceeds the cleanup goal for the future construction worker (240 ng/kg $TEQ_{DF,M}$). The upper 10 feet depth is based on the depth for the exposure scenario, i.e., construction worker. Dioxin concentrations in the upper 10 feet of soil exceed the cleanup goal at four locations. Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place. Under this remedial alternative, the following institutional controls would be implemented:

- Deed restrictions would be applied to parcels in which the depth-weighted average dioxin concentrations in the upper 10 feet of subsurface soil exceed the soil cleanup goal for the future construction worker

- Notices would be attached to deeds of affected properties to alert potential future purchasers of the presence of waste and soil with dioxin concentrations exceeding the soil cleanup goal.

- The institutional controls will be implemented and maintained by the PRPs with oversight by EPA and TCEQ.

- As a result of the long term persistence of dioxin, it is anticipated that the institutional controls will be essentially permanent measures.

Alternative 3S – Enhanced Institutional Controls and Ground Water Monitoring

Estimated Capital Cost: $367,000
Estimated Post Construction Cost: $1.04 million
Estimated Total Present Worth Cost: $1.4 million
Estimated Construction Time: 1 month

This remedial alternative would incorporate the Institutional controls identified in Alternative 2S and add physical features to enhance the effectiveness of the institutional controls. The physical features would include bollards to define the areal extent of the remedial action areas at the surface and a marker layer that would alert workers digging in the area that deeper soil may be impacted.
Implementation of this remedial alternative may include the following steps:

- Removing up to 2 feet of surface soil
- Temporarily stockpiling the soil onsite
- Placing the marker layer (such as a geogrid or similar durable and readily visible material) at the bottom of the excavation
- Returning the soil to the excavation and re-establishing vegetative cover
- Placing bollards at the corners of the remedial action areas.
- Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place.

Alternative 4S – Removal and Offsite Disposal, Institutional Controls

Estimated Capital Cost: $9.07 million
Estimated Post Construction Cost: $0.85 million
Estimated Total Present Worth Cost: $9.9 million
Estimated Construction Time: 7 months

This remedial alternative involves excavation and replacement of soil in the areas exceeding the preliminary remediation goals. Soil would be removed within these areas to a depth of 10 feet below grade. The upper 10 feet excavation depth is based on the depth for the exposure scenario, i.e., construction worker. Implementation of this remedial alternative would require dewatering to lower the water table to allow excavation of impacted soil in relatively dry conditions, and may need to be timed to try to avoid high water and periods when storms are most likely. Excavated soil would be further dewatered or solidified, as necessary, prior to transporting it for disposal. Effluent from excavation and subsequent dewatering would need to be handled appropriately, potentially including treatment prior to disposal. Excavated soil would be disposed of at an existing permitted landfill, the excavation would be backfilled with imported soil, and vegetation would be re-established. An existing building (an elevated frame structure) and a concrete slab would need to be demolished and removed prior to excavating the underlying soil. These features would be

replaced, if necessary. Ground water monitoring is not a part of this Alternative 4S because material containing dioxin above the PRG will be removed and disposed of off-site.

The removal volume (50,000 cubic yards) was calculated assuming a conservative excavation side slope of 2 horizontal to 1 vertical. Transportation and disposal costs were estimated assuming that all of the excavated material would be transported to a licensed landfill for disposal. Institutional controls will applied to insure the continued industrial use of the area.

Evaluation of Alternatives

This section of the Proposed Plan discusses the relative performance of each alternative against the nine criteria and the rationale for selecting the Preferred Alternatives. The 12 alternatives are as follows, one must be selected for each area:

Alternatives for the San Jacinto River and Area North of I-10:

- 1N – Armored Cap and Ongoing Operations, Monitoring, and Maintenance (No Further Action)
- 2N – Armored Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery
- 3N – Permanent Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery
- 3aN – Enhanced permanent Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery
- 4N – Partial Solidification/Stabilization, Permanent Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery
- 5N – Partial Removal, Permanent Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery
- 5aN – Partial Removal of Materials Exceeding Cleanup Levels, Permanent Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery
- 6N – Full Removal of Materials Exceeding Cleanup Levels using BMPs and Institutional Controls

Alternative Evaluation

The NCP requires the use of nine criteria to evaluate the difference of remediation alternatives individually and in comparison to each other. These criteria include *threshold criteria*, which requires that each alternative must meet in order to be eligible for selection. *Primary balancing criteria* are used to weigh major trade-offs among alternatives, and *modifying criteria* involve state and community acceptance.

The two threshold criteria are: 1) overall protection of human health and the environment, and 2) compliance with ARARs. The five primary balancing criteria are: 3) long-term effectiveness and permanence; 4) reduction of toxicity, mobility, or volume through treatment; 5) short-term effectiveness; 6) implement-ability; and 7) cost. The two modifying criteria are: 8) state acceptance, and 9) community acceptance. EPA assesses public comment on the Proposed Plan to gauge community acceptance.

Alternative for the Southern Impoundment:

- 1S – No Further Action
- 2S – Institutional Controls and Ground Water Monitoring
- 3S – Enhanced Institutional Controls and Ground Water Monitoring
- 4S – Removal and Offsite Disposal.

Several treatment technologies, including thermal (in-pile thermal desorption) and chemical (solvated electron technology and base catalyzed decomposition) processes, were also considered for use at the Site but were not included in a remedial alternative.

In-Pile Thermal Desorption technology uses a heated negative pressure environment to treat contaminated soils and sediments. Excavated material is placed in piles or "cells" for treatment. Each "cell" is constructed above ground with a foundation, containment berms, insulating walls and cover, and treatment wells. Thermal desorption is a slow process, requiring months to treat a batch of sediment. If the selected remedy includes removing a significant volume of sediment, using thermal desorption would require the use of a large amount of land either to house multiple treatment piles or to stage sediment awaiting treatment. Because of the large space requirement, a temporary thermal desorption facility would need to be established off-site and would need to obtain operating permits. For smaller volumes of sediment, the cost of siting a treatment facility would not be warranted. Thermal desorption was not retained because incineration would provide a more implementable thermal treatment option for a roughly similar cost.

The Solvated Electron Technology™ (SET) is an ex situ chemical dehalogenation treatment process. The process involves mixing the contaminated soil or sediment with a solvated electron solution (alkali metal or alkaline earth metal mixed in liquid anhydrous ammonia) in a treatment vessel. Chlorine is removed from the chlorinated organic molecules, leaving the parent contaminant molecule (non-chlorinated dioxin in this case) and metal salts, such as sodium chloride. The vessel is then heated using hot water or steam to remove the ammonia for reuse. Based on the available information, the SET chemical dehalogenation treatment technology is not currently available for full-scale implementation in the United States. As a result, this process option was not retained for further evaluation.

Base-catalyzed decomposition (BCD) is another ex situ technology that has been applied in the United States and countries around the world. The patent holder of this technology in the United States is the USEPA. This treatment technology requires pre-treatment via thermal desorption to remove the contaminants from the soil/sediment matrix by volatilization. The volatilized contaminants pass through a condenser and are fed into a liquid tank reactor along with sodium hydroxide and a carrier oil. The mixture is then heated for 3 to 6 hours to temperatures above 326°C. The oil is tested post-treatment and the carbonaceous residues formed from the reaction are removed from the mixture; the carrier oil can then be reused for subsequent treatment applications. The soil and sediment treated via thermal desorption can be reused as fill material. Based on the available information, the BCD treatment technology is not currently available for full-scale implementation in the United States. As a result, this process option was not retained for further evaluation.

The FS contains a detailed analysis of each alternative against the criteria and a comparative analysis of how the alternatives compare to each other, a summary is provided below.

Threshold Criteria

All of the remedial alternatives evaluated in the FS for the area north of I-10 satisfy the threshold criteria of protecting human health and the environment and addressing ARARs (Table 1). Several facilities have been identified that could potentially receive the waste material, however, the actual disposal location would be determined during the Remedial Design. The surface-weighted average dioxin concentration in surface sediments (which are associated with a variety of dioxin sources in addition to paper mill waste that was placed in the impoundments) was reduced by more than 80 percent by the implementation of the TCRA. The current (post-TCRA) condition potential for exposure to dioxin concentrations is protective of

human health and the environment, unless there is a future release, which may result from an extreme storm or hurricane, or the impacts of a barge strike.

The San Jacinto site is classifiable as a water of the U.S. Dredge and fill permits are applicable to dredging, in-water disposal, capping, construction of berms or levees, stream channelization, excavation and/or dewatering within waters of the U.S. Permits are not required, however, for on-site CERCLA actions. Under the 404(b)(1) guidelines, efforts should be made to avoid, minimize, and mitigate adverse effects on the waters of the U.S. and, where possible, select a practicable (engineering feasible) alternative with the least adverse effects. The substantive requirements of Section 404 were considered in the selection of the preferred remedial action. The preferred remedial action is designed to minimize adverse impacts to waters of the U.S. through the use of best management practices to minimize impacts to the San Jacinto River. An evaluation of Section 404(b)(1) CWA compliance was prepared for the TCRA installation. A supplemental 404(b)(1) report may need to be prepared during the Remedial Design depending on the nature of the selected remedy.

There are significant differences between the northern area alternatives regarding the amount of potential dioxin impacts to the San Jacinto River, and when those impacts may occur. For example, Alternative 3N (Permanent Cap) would not result in any significant short term dioxin impact during construction because the existing cap is not removed. However, based on the Corps of Engineers review (Appendix A of the

Feasibility Study), a severe future storm could result in significant erosion of 80% of the armor cap and up to 2.4 feet of scour into the waste pits.

Alternative 3aN is an enhanced capping alternative with armor cap improvements (larger, 15" armor stone, 24" of additional cap thickness on top of the Alternative 3N cap) recommended by the Corps of Engineers to address the deficiencies of Alternative 3N. Alternative 3aN would be better able to withstand a future severe storm. However, there still remains the uncertainties of changes in channel planform morphology that may occur due to bank erosion, shoreline breaches, etc. during a high flow event caused by a major flood or hurricane, which is beyond the ability of existing sediment transport models to simulate, as well as the uncertainty of making predictions that would have to remain relevant for hundreds of years into the future. To add to these uncertainties, future flooding may be even more intense. According to the U.S. National Climate Assessment, flooding along rivers and other areas following heavy downpours and prolonged rains is exceeding the limits of flood protection infrastructure designed for historical conditions. Sea level rise, storm surge, and heavy downpours in combination with the pattern of continued development in coastal areas are increasing damage to U.S. infrastructure and are also increasing risks to ports and other installations.

For the area south of I-10, other than Alternative 1S, the remedial alternatives considered in the FS Report meet both of the threshold criteria: protectiveness and compliance with ARARs. The potentially affected receptor (future construction worker) would be protected from exposure to soil with elevated dioxin concentrations by warnings and restrictions (Alternatives 2S and 3S) or removal of impacted soil (Alternative 4S). With reasonable care, any of the remedial alternatives could be implemented in compliance with ARARs. Soil that is removed (Alternative 4S) would be transported in compliance with applicable requirements and permanently managed in a permitted landfill cleared by the EPA's regional offsite rule contact.

Primary Balancing Criteria – Long-Term Effectiveness and Permanence

Alternatives 1N, 2N, and 3N are containment alternatives that provide long-term protectiveness. However, future flooding may be even more intense than experienced in the past, which increases the uncertainty of the long-term effectiveness of all of the containment alternatives. According to the U.S. National Climate Assessment, flooding along rivers and other areas following heavy downpours and prolonged rains is exceeding the limits of flood protection infrastructure designed for historical conditions. Sea level rise, storm surge, and heavy downpours in combination with the pattern of continued development in coastal areas are increasing damage to U.S. infrastructure and are also increasing risks to ports and other installations.

Alternatives 4N, 5N, and 5aN all provide increased long term effectiveness compared to Alternatives 1N, 2N, and 3N because the most highly contaminated waste would either be stabilized or removed. As discussed in the site characteristics section (pages 5 and 6) the area is prone to tropical storms and hurricanes which could damage a cap. Alternative 6N provides the greatest long-term protectiveness and effectiveness because the waste material, except for the dredge residuals below the cover layers, would be permanently removed from the San Jacinto River and there would be no potential for a future release above the risk based level from the Site. Also, with Alternative 6N, there would be no concerns regarding the long-term viability and effectiveness of a maintenance program that would have to endure for an extremely long time (750 years by one estimate). Alternative 6N is also the only alternative that provides for complete removal of the principle threat waste from the northern impoundments. Ground water monitoring would be included in Alternatives 2N through 5aN, where waste above the preliminary

remediation goals is left in place, to confirm that there would be no long-term future unacceptable impacts to ground water.

For the area south of I-10, soil with dioxin concentrations exceeding the cleanup goal is isolated from the surface by relatively clean overburden. The only route of potential exposure is through excavation into the impacted depth interval. The physical markers (Alternative 3S) would draw attention to the institutional controls and enhance their effectiveness. Alternative 4S would achieve long-term effectiveness by permanently removing the impacted soil from the 0- to 10-foot depth interval from the Site and securely disposing of the soil in a permitted landfill. While the institutional controls, particularly with the addition of physical markers (Alternative 3S), would provide reliable long-term protection, they rely on the integrity of future construction workers to comply with the restrictions. Therefore, complete removal of the impacted soil in the depth interval of potential excavation (Alternative 4S) will provide the highest level of long-term effectiveness because it is not subject to inappropriate future use of the area or any erosion/scour of the waste material that may result from a future extreme storm. Alternative 4S is also the only alternative that provides for complete removal of the principle threat waste from the southern impoundment. Ground water monitoring would be included in Alternatives 2S and 3S, where waste above the preliminary remediation goals is left in place, to confirm that there would be no long-term future unacceptable impacts to ground water.

Primary Balancing Criteria – Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 1N and 2N do not include additional measures to reduce the toxicity, mobility, or volume of material. However, a portion of the soils in the western cell were previously solidified during the TCRA. Thus, these alternatives are comparable in reduction of toxicity, mobility, or volume of material. Alternative 3N further reduces potential mobility within the TCRA site by increasing the protection of the armored slopes, and thus ranks more favorably than Alternatives 1N and 2N. Alternatives 4N and 5N take additional measures through solidification and stabilization (Alternative 4N) or removal (Alternative 5N) of approximately 52,000 cubic yards of sediments and soils, and are comparatively better than Alternative 3N for reduction of toxicity, mobility, or volume of material. Alternative 5aN removes approximately 137,600 cubic yards of sediment, and thus compares more favorably for reduction of toxicity, mobility, or volume of material than Alternatives 4N and 5N. Alternative 6N has the greatest volume of removal – 200,100 cubic yards. This alternative is the most effective in reducing the toxicity, mobility, and volume of waste compared to all of the other alternatives.

Alternatives 1S, 2S and 3S do not include any reduction in the toxicity, mobility, or volume of impacted soil. Alternative 4S is the only alternative that reduces the volume by complete removal of soils above the PRG, and would include treatment of excavated soil as needed to eliminate free liquids for transportation and disposal. The treatment may involve amendment of the soil with Portland cement or similar product, which would reduce the potential mobility of contaminants of concern (COCs).

Primary Balancing Criteria – Short-Term Effectiveness

Alternatives 1N and 2N do not entail any construction, and thus have no short-term impacts. Alternative 3N has the shortest construction duration (two months) of the remaining alternatives. Alternatives 3aN, 4N, 5N, 5aN, and 6N have estimated construction durations ranging from 13 to 19 months. Alternative 3N does not result in water column, sediment, or tissue impacts (except for minor turbidity during armor rock placement), and has the lowest risk to worker safety, the lowest greenhouse gas and particulate matter emissions, and the least traffic and ozone (smog) impact. Further, Alternative 3N does not disturb the armored cap or require handling of sediments. Compared to Alternatives 4N, 5N, 5aN, and 6N, which all

include at least some cap removal, Alternatives 3N and 3aN rank more favorably for short-term effectiveness because there is no cap removal and little potential for short-term dioxin releases to the San Jacinto River.

All of the alternatives involving either partial or full removal, including Alternatives 5N, 5aN, and 6N, would have re-suspension of sediment. Alternative 5N uses silt curtains to control the re-suspension of sediment. Silt curtains are the lease effective controls. Alternative 5aN uses more effective re-suspension controls including sheet piles and earthen berms. Alternative 6N adds removal in the dry in addition to sheet piles and earthen berms and results in the most effective control of re-suspension.

The actual design and application of BMPs for construction will be determined during the Remedial Design.

Alternatives 4N, 5N, 5aN, and 6N each have short-term impacts associated with sediment residuals and re-suspension as well as a high-water event during construction. However, the actual impacts would be reduced to the maximum extent practicable by the use of BMPs during construction, especially in Alternative 6N with the most extensive application of BMPs.

Alternative 5aN and 6N has a longer construction duration than the other alternatives. Compared to the other alternatives, there is higher potential worker safety issues and higher environmental impacts due emissions of ozone precursors, particulate matter (smog-forming), and greenhouse gases.

BMPs can successfully mitigate and control re-suspension of sediment. Alternative 6N, the preferred alternative, will include design and construction methodologies to mitigate and reduce the impact of storms during construction. These methodologies may include armor cap removal in sections, raised berms, operational controls, etc. Substantial containment structures are needed to isolate the removal operations, residuals and exposed sediment. To control the sediment rre-suspension during construction, the containment structures would consist of berms and sheet pile walls or caissons to an elevation of about +10 NAVD88 (protection from 25-year or 50-year flood stage). If performing excavation of the sediments in the dry, the top of the berms would preferably be no lower than +5 NAVD88 (protection from 5-year or 10-year flood stage).

For the Southern Impoundment, Alternative 2S for the southern area does not entail any construction, and thus has no short-term impacts. Excavations (Alternatives 3S and 4S) would require BMPs to control dust and storm water. Short-term impacts associated with Alternative 3S would be minimal given the shallow depth of excavation, limited volume of material that would be moved, and absence of significant concentrations of COCs in the shallow soil. Alternative 4S would require exposing soil with dioxin concentrations exceeding the Preliminary Remediation Levels, which introduces the potential for exposure to COCs through direct contact with the soil, inhalation or ingestion of impacted dust, and contact with impacted soil suspended in runoff. The volume of soil and the duration of the project would also be greater than for Alternative 3S; and Alternative 4S would require offsite transportation of the soil to a disposal facility, increasing the potential for exposure to COCs, emissions of greenhouse gasses, nitrogen oxides, and particulate matter, and potential tracking of COCs offsite. However, measures developed in the Remedial Design would be implemented to reduce the amount of any materials lost during transportation.

Primary Balancing Criteria – Implementability

Alternatives 1N and 2N do not have any implementability issues because they do not entail construction. Both are more favorable from an implementability standpoint compared to Alternatives 3N, 4N, 5N, 5aN, and 6N. Alternative 3N is a short-duration project that entails proven technology (i.e., the same activities

were demonstrated during construction of the armored cap) that can be deployed with readily-available materials and local, experienced contractors.

Implementability issues, such as TCRA site access, limited staging areas, restrictions on equipment size, and availability of offsite staging area properties are greater for Alternatives 4N, 5N, 5aN, and 6N compared to Alternative 3N because of the much larger scope and scale of these alternatives. Identifying and securing an offsite staging area is considered an even greater challenge for Alternatives 5N, 5aN, and 6N compared to Alternative 4N because dredged sediment may need to be managed at the offsite staging area, which requires a larger footprint, and given the nature of the dredged material, might make finding a willing landowner difficult. Proper management of cap material and excavated wastes, and onsite processing and management for dredged sediments for offsite transportation to neighboring roadways, will be critical for effective implementation of Alternatives 5N, 5aN, and 6N.

For the southern area, there are no significant implementability concerns associated with Alternatives 2S and 3S. None of the alternatives requires specialized equipment, techniques, or personnel. Coordination with property owners would be required to establish institutional controls and for access to the project work site. Alternative 4S would involve more physical activity for implementation, including offsite transportation of impacted soil, but the operations are routine for remedial actions. The additional implementability concerns are the increased truck traffic on Market Street and the potential for flooding while impacted soil is exposed during implementation of Alternative 4S. Provisions may need to be made to handle the additional volume of traffic. The duration of the excavation should not exceed 7 months, and implementation could be timed for periods when high water is least likely.

Primary Balancing Criteria – Cost

The estimated present worth costs for alternatives range from $143,000 million for Alternative 1N to $101 million for Alternative 6N, and from $0.14 million for Alternative 1S to $9.9 million for Alternative 4S. Costs for each alternative are presented with the descriptions of each alternative.

Modifying Criteria

TCEQ has been informed about the Preferred Remedy for the Site. Community acceptance will be determined through the Public Comment process based on comments received during the public comment period and the questions received at the public meeting.

Preferred Remedy

The Preferred Remedy for cleaning up the Site is Alternative 6N (Full Removal of Materials Exceeding Cleanup Levels and Institutional Controls) and Alternative 4S (Removal and Offsite Disposal with Institutional Controls). These alternatives will achieve protectiveness by removal of material containing dioxin at concentrations greater than the PRGs, resulting in a Site hazard index of less than one following remediation. The removed material will be transported to and disposed of at a permitted permanent disposal facility. Based on current conditions, future sediment deposition at the Site will result in a sediment concentration that is less than 7.2 ng/kg (upstream background concentration), well below the Site PRG for dioxin in river sediment of 30 ng/kg.

Based on the information available at this time, EPA believes that the Preferred Remedy is protective of human health and the environment, complies with ARARs, and provides the best balance of tradeoffs

among the balancing criteria. It reduces risks within a reasonable time frame, provides for long-term reliability of the remedy, and minimizes reliance on institutional controls. It will achieve substantial risk reduction by removing the contaminated materials and manages the remaining risks to human health through institutional controls.

EPA considered several options for contaminated materials. EPA's preferred remedy includes full removal of contaminated materials above cleanup levels for the following reasons:

- The material is highly toxic and under baseline conditions may be highly mobile in a severe storm and therefore is considered a principal threat waste. The EPA considers material at the Site with more than 300 ng/kg dioxin to be principle threat waste. This concentration was calculated by multiplying the sediment river sediment PRG of 30 ng/kg by a factor of 10.

- The location of materials, either partially submerged within the San Jacinto River (northern impoundments) or on a small peninsula on the San Jacinto River (southern impoundment), result in limited ability to treat the waste in place without increased threat of a release during the remedial action.

- The area has a high threat of repeated storm surges and flooding from hurricanes and tropical storms, which, if the material was left in place, could result in a release of hazardous substances.

- The history of repeated armor cap maintenance as a result of floods that are much less severe than the design 100-year flood.

For all of these factors, the Preferred Remedy provides greater permanence in comparison to other alternatives. Less costly alternatives rely on remedies that have a higher chance of failure by leaving principal threat waste source materials in the river, resulting in greater uncertainty as to their long-term effectiveness.

The Preferred Remedy can change in response to public comment or new information.

Glossary

Administrative Record – All documents which the EPA considered or relied upon in selecting the response action at a Superfund site, culminating in the Record of Decision for a Remedial Action.

Applicable, Relevant, and Appropriate Requirements (ARARs) – Generally, any Federal, State, or local requirements or regulations that would apply to a remedial action if it were not being conducted under CERCLA, or that while not strictly applicable, are relevant in the sense that they regulate similar situations or actions and are appropriate to be followed in implementing a particular remedial action.

Contaminants of Concern (COCs) - Those chemicals that are identified as a potential threat to human health or the environment, are evaluated further in the baseline risk assessment, and are identified in the RI/FS as needing to be addressed by the response action proposed in the Record of Decision.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) – Also known as Superfund. CERCLA is a Federal law passed in 1980 and modified in 1986 by the Superfund

Amendments and Reauthorization Act. Under CERCLA, the EPA can either pay for the site cleanup or take legal action to force parties responsible for site contamination to clean up the Site or pay back the Federal government for the cost of the cleanup.

Baseline Ecological Risk Assessment (BERA) – A study that determines and evaluates risks that site contamination poses to ecological receptors.

Code of Federal Regulations (CFR) - Codification of the general and permanent rules published in the Federal Register by the departments and agencies of the Federal Government.

Dioxins - Concentration calculated for dioxin and furan congeners using toxicity equivalency factors for mammals (Toxicity Equivalents, or TEQ).

Dioxin-Like PCBs - Concentration calculated for polychlorinated biphenyl (PCB) congeners using toxicity equivalency factors for mammals (Toxicity Equivalents, or TEQ).

Engineering Controls – Instruments such as fencing or signage that are used to limit access to contaminated areas or areas that may pose a physical hazard.

Feasibility Study (FS) – A detailed evaluation of alternatives for cleaning up a site.

Five-Year Reviews – A review generally required by statute or program policy when hazardous substances remain at a site above levels which permit unrestricted use and unlimited exposure. Five-year reviews provide an opportunity to evaluate the implementation and performance of a remedy to determine whether it remains protective of human health and the environment. Reviews are performed five years after completion of the remedy construction at Superfund-financed sites, and are repeated every succeeding five years so long as future uses at a site remain restricted.

Hazard Index (HI) – In the baseline risk assessment, ration of the dose calculated for a receptor divided by the toxicity value. When the HI exceeds 1.0, a health risk or ecological risk is assumed to exist.

Human Health Risk Assessment (BHHRA) – Estimates the current and possible future risk if no action were taken to clean up a site. The EPA's Superfund risk assessors determine how threatening a hazardous waste site is to human health and the environment. They seek to determine a safe level for each potentially dangerous contaminant present (e.g., a level at which ill health effects are unlikely and the probability of cancer is very small). Living near a Superfund site doesn't automatically place a person at risk; that depends on the chemicals present and how a person is exposed to the chemical.

Implementability – One of EPA's primary balancing criteria addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Institutional Controls – Non-engineered instruments, such as administrative and/or legal controls, that help to minimize the potential for human exposure to contamination and/or protect the integrity of the remedy. Institutional controls work by limiting land or ground water use and/or providing information that helps modify or guide a person's action at a site. Some common examples include restrictive covenants, deed notices, or local ordinances.

Long-term Effectiveness and Permanence – One of EPA's primary balancing criteria that refers to the expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Monitored Natural Recovery (MNR) - A technology in which contaminant concentrations are monitored with no other remedial actions taken to address contamination. MNR assesses the natural attenuation of contaminants by physical, chemical, and biological processes.

Operable Unit - An operable unit is a discrete action that comprises an incremental step toward comprehensively addressing site contamination.

Nanograms per Kilogram (ng/kg) - Is a measurement of concentration used to measure how many nanograms of a contaminant are present in one kilogram of solid material (e.g., soil, sediment, tissue). One ng/kg is equal to 0.000001 milligrams per kilogram (mg/kg).

National Priorities List (NPL) – EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial response.

Preliminary Remediation Goal (PRG) - Upper concentration limits for specific chemicals in specific environmental media that are anticipated to protect human health or the environment.

Principal Threat Wastes - Those materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. The EPA expects to use treatment when practical to address the principal threats posed by a site. The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to ground water, surface water, or air, or acts as a source for direct exposure.

Reasonable Maximum Exposure (RME) – The maximum exposure reasonably expected to occur in a population.

Reduction of Toxicity, Mobility, or Volume Through Treatment – One of EPA's primary balancing criteria that refers to the anticipated performance of the treatment technologies that may be included as part of the remedy.

Remedial Investigation (RI) – The collection and assessment of data to determine the nature and extent of contamination at a site.

Surface Area - Weighted Average Concentration (SWAC) – Average concentration for an area calculated by applying a surface area weighting factor to each concentration value.

Short-term Effectiveness – One of EPA's primary balancing criteria that addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

$TEQ_{DF,M}$ – 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity equivalent quotient calculated using toxicity equivalent factors for mammals

$TEQ_{P,M}$ – Dioxin-like PCB congener toxicity equivalent quotient calculated using toxicity equivalency factors for mammals.

SITE TABLES

Table 1
Applicable or Relevant and Appropriate Requirements Summary

Potential ARARs[1]	Citation	Summary	Comment
Federal			
Clean Water Act (CWA): Criteria and standards for imposing technology-based treatment requirements under §§ 309(b) and 402 of the Act	33 U.S.C. §§ 1319 and 1342 (implementing regulations at 40 CFR Part 125 Subpart A)	Both on-site and off-site discharges from CERCLA sites to surface waters are required to meet the substantive CWA (National Pollutant Discharge Elimination System) NPDES requirements (USEPA 1988).	On-site discharges must comply with the substantive technical requirements of the CWA but do not require a permit (USEPA 1988). Off-site discharges would be regulated under the conditions of a NPDES permit (USEPA 1988). Standards of control for direct discharges must meet technology-based requirements. Best conventional pollution control technology (BCT) is applicable to conventional pollutants. Best available technology economically achievable (BAT) applies to toxic and non-conventional pollutants. For CERCLA sites, BCT/BAT requirements are determined on a case-by-case basis using best professional judgment. This is likely to be a potential requirement only if treated water or excess dredge water is discharged during implementation.
CWA Sections 303 and 304: Federal Water Quality Criteria	33 U.S.C. §§1313 and 1314 (Most recent 304(a) list as updated to issuance of ROD)	Under §303 (33 U.S.C. §1313), individual states have established water quality standards to protect existing and attainable uses (USEPA 1988). CWA §301(b)(1)(C) requires that pollutants contained in direct discharges be controlled beyond BCT/BAT equivalents (USEPA 1988). CERCLA §121(d)(2)(B)(i) establishes conditions under which water quality criteria, which were developed by USEPA as guidance for states to establish location-specific water quality standards, are to be considered relevant and appropriate. Two kinds of water quality criteria have been developed under CWA §304 (33 U.S.C. §1314): one for protection of human health, and another for protection of aquatic life. These requirements include establishment of total maximum daily loads (TMDL).	The FS considers the ability of remedial alternatives to satisfy established water quality criteria. Best management practices (BMPs) would be established for remedial actions and applied during construction. Water quality would also be monitored during construction and additional BMPs may be implemented if necessary to protect water quality. Where water quality state standards contain numerical criteria for toxic pollutants, appropriate numerical discharge limitations may be derived for the discharge and considered (USEPA 1988). Where state standards are narrative, either the whole-effluent or chemical-specific approach may generally be used as a standard of care (USEPA 1988).
CWA Section 307(b): Pretreatment standards	33 U.S.C. §1317(b)	CERCLA §121(e) states that no Federal, state, or local permit for direct discharges is required for the portion of any removal or remedial action conducted entirely on-site (the aerial extent of contamination and all suitable areas in close proximity to the contamination necessary for implementation of the response action) (USEPA 1988).	If off-site discharges from a CERCLA response activity were to enter receiving waters directly or indirectly, through treatment at a Publicly Owned Treatment Works (POTWs), they must comply with applicable Federal, State, and Local substantive requirements and formal administrative permitting requirements (USEPA 1988). This requirement may be triggered by disposal methods for waste. Based on the current set of proposed alternatives, none of the alternatives involve discharge to a POTW, and therefore, this regulation is not likely to be applicable.
CWA Section 401: Water Quality Certification	33 U.S.C. §1341	Requires applicants for Federal permits for projects that involve a discharge into navigable waters of the U.S. to obtain certification from state or regional regulatory agencies that the proposed discharge will comply with CWA Sections 301, 302, 303, 306, and 307.	Proposed activities that are on-site would not require a Federal permit. Therefore, certification is not legally required for on-site actions. Certification would be required for off-site actions. For on-site or off-site actions, certification should occur as part of the state identification of substantive state ARARs (USEPA 1988). Compliance with water quality criteria is discussed under CWA Sections 303 and 304.

[1] ARARs are applicable or relevant and appropriate requirements of Federal or state environmental laws and state facility siting laws. CERCLA section 121(d) requires that remedial actions generally comply with ARARs. The USEPA has stated a policy of attaining ARARs to the greatest extent practicable on remedial or removal actions (USEPA 1988). USEPA also stated that certain nonpromulgated Federal and state advisories or guidelines would be considered in selecting remedial or removal actions; these guidelines are referred to as TBCs, or "to be considered."

Table 1
Applicable or Relevant and Appropriate Requirements Summary

Potential ARARs[1]	Citation	Summary	Comment
CWA Section 404 and 404(b)(1): Dredge and Fill	33 U.S.C. §1344 (b)(1) (implementing regulations at 33 CFR 320 and 330; 40 CFR 230)	Discharges of dredged and fill material into waters of the U.S. must comply with the CWA §404 (33 U.S.C. 1344) guidelines and demonstrate the public interest is served (USEPA 1988).	The San Jacinto site is a water of the U.S. (USEPA 2007). Dredge and fill permits are applicable to dredging, in-water disposal, capping, construction of berms or levees, stream channelization, excavation and/or dewatering within waters of the U.S. (USEPA 1988). Permits are not required, however, for on-site CERCLA actions. Under the 404(b)(1) guidelines, efforts should be made to avoid, minimize, and mitigate adverse effects on the waters of the U.S. and, where possible, select a practicable (engineering feasible) alternative with the least adverse effects. The substantive requirements of Section 404 will be considered in the development and evaluation of remedial alternatives to minimize adverse impacts to waters of the U.S.
Safe Drinking Water Act	42 U.S.C. §300f (implementing regulations at 40 CFR Part 141, et seq.)	The Safe Drinking Water Act is applicable to public drinking water sources at the point of consumption ("at the tap"). Maximum contaminant levels (MCLs) have been established for certain constituents to protect human health and to preserve the aesthetic quality of public water supplies.	Safe Drinking Water Act standards are applicable to public drinking water sources. The San Jacinto River is not a public water supply and does not recharge an aquifer used to supply drinking water. Therefore, the Safe Drinking Water Act is not applicable. The MCL for 2,3,7,8-tetrachlorodibenzodioxin may be considered for protecting water quality.
Federal Drinking Water Regulations (Primary and Secondary Drinking Water Standards)[2]	40 CFR 141 and Part 143	USEPA has established two sets of drinking water standards: one for protection of human health (primary) and one to protect aesthetic values of drinking water (secondary) (USEPA 1988). MCLs are applicable to public drinking water sources at the point of consumption.	Safe Drinking Water Act standards are applicable to public drinking water sources. The San Jacinto River is not a public water supply and does not recharge an aquifer used to supply drinking water. Therefore, the Safe Drinking Water Act is not applicable. The MCL for 2,3,7,8-tetrachlorodibenzodioxin may be considered for protecting water quality.
Resource Conservation And Recovery Act (RCRA): Hazardous Waste Management	42 U.S.C. §§6921 et seq. (implementing regulations at 40 CFR Parts 260 – 268)	RCRA is intended to protect human health and the environment from the hazards posed by waste management (both hazardous and nonhazardous). RCRA also contains provisions to encourage waste reduction. RCRA Subtitle C and its implementing regulations contain the Federal requirements for the management of hazardous wastes.	This requirement would apply to certain activities if the affected sediments contain RCRA listed hazardous waste or exhibit a hazardous waste characteristic. RCRA requirements are applicable only if waste is managed (treated, stored, or disposed of) after effective date of RCRA requirement under consideration or if CERCLA activity constitutes treatment, storage, or disposal as defined by RCRA. The sludge and sediment at the site are not listed hazardous waste, do not contain listed hazardous waste, and do not meet any of the characteristics of hazardous waste. Therefore, the RCRA rules for hazardous waste are neither applicable nor relevant and appropriate.
Toxic Substances Control Act (TSCA)	15 USC §2601 et. seq. (implementing regulations at 40 CFR 761)	Potentially applicable to PCB-contaminated sediment or surface water. Requires remedial action of certain PCB releases depending on the concentration of the source material and the date of the release (or the as-found concentration for releases where the date is undetermined). Disposal and treatment requirements are also specified for environmental media if removed depending on total PCB concentrations.	Total PCB concentrations in in soil and sediment are below the regulatory threshold (50 mg/kg, calculated as specified in 40 CFR 761) that would require remedial action or trigger certain requirements for waste management.
RCRA: General Requirements for Solid Waste Management	42 U.S.C. §§6941 et seq. (implementing regulations at 40 CFR 258)	Requirements for construction for municipal solid waste landfills that receive RCRA Subtitle D wastes, including industrial solid waste. Requirements for run-on/run-off control systems, groundwater monitoring systems, surface water requirements, etc.	This requirement would be relevant if a landfill was constructed for the disposal of non-hazardous solid waste. There are no specific Federal requirements for non-hazardous waste management; state regulations provide specific applicable requirements for siting, design, permitting, and operation of landfills.
Clean Air Act (CAA)	42 U.S.C. §§7401 et seq.	Would apply if dredging and/or excavation activities generate air emissions sufficient to require a permit, greater than 10 tons of any pollutant per year under the CAA operational permit (USEPA 2009).	None of the remedial alternatives is expected to trigger an operational permit.

[2] Underground injection is not anticipated as a part of the potential remedial action. Furthermore, the site is not located in a sole-source aquifer (USEPA 2008). It is also assumed that no wellhead protection area is located near the study area.

Table 1
Applicable or Relevant and Appropriate Requirements Summary

Potential ARARs[1]	Citation	Summary	Comment
Rivers And Harbors Act of 1899: Obstruction of navigable waters (generally, wharves; piers, etc.); excavation and filling-in	33 U.S.C. §401	Controls the alteration of navigable waters (i.e., waters subject to ebb and flow of the tide shoreward to the mean high water mark). Activities controlled include construction of structures such as piers, berms, and installation of pilings as well as excavation and fill. Section 10 may be applicable for any action that may obstruct or alter a navigable waterway.	No permit is required for on-site activities. However, substantive requirements might limit in-water construction activities.
Endangered Species Act	16 U.S.C. §§ 1531 et seq.	Federal agencies must ensure that actions they authorize, fund, or carry out are not likely to adversely modify or destroy critical habitat of endangered or threatened species. Actions authorized, funded, or carried out by Federal agencies may not jeopardize the continued existence of endangered or threatened species as well as adversely modify or destroy their critical habitats.	Based on a 2010 evaluation, as well as a desktop review of site photos and USFWS and NMFS species and habitat maps, no Federally listed threatened or endangered (T&E) species or their critical habitat are present on the site or utilize areas in the vicinity of the site. Therefore, this requirement is not relevant to the evaluation of remedial alternatives. NMFS includes endangered sea turtles in Trust resources impacted by contaminated surface water and sediments that may have been transported from the site. USEPA will consult with the resource agencies to gain concurrence on the determination that the proposed remedial alternative will have no effect on listed species.
Fish and Wildlife Coordination Act	16 U.S.C. §§661 et seq., 16 U.S.C. §742a, 16 U.S.C. § 2901	Requires adequate provision for protection of fish and wildlife resources. This title has been expanded to include requests for consultation with USFWS for water resources development projects (Mueller 1980). Any modifications to rivers and channels require consultation with the USFWS, Department of Interior, and state wildlife resources agency[3]. Project-related losses (including discharge of pollutants to water bodies) may require mitigation or compensation.	Applicable to any action that controls or modifies a body of water.
Bald and Golden Eagle Protection Act	16 U.S.C. §668a-d	Makes it unlawful to take, import, export, possess, buy, sell, purchase, or barter any bald or golden eagle, nest, or egg. "Take" is defined as pursuing, hunting, shooting, poisoning, wounding, killing, capturing, trapping and collecting, molesting, or disturbing.	This requirement is potentially relevant to CERCLA activities. No readily available information suggests bald or golden eagles frequent the project area; however, a qualified biologist would perform a site visit prior to a potential remedial action to confirm that bald and golden eagles do not frequent the project area.
Migratory Bird Treaty Act	16 U.S.C. §§703-712 (implementing regulations at 50 CFR §10.12)	Makes it unlawful to take, import, export, possess, buy, sell, purchase, or barter any migratory bird. "Take" is defined as pursuing, hunting, shooting, poisoning, wounding, killing, capturing, and trapping and collecting.	This requirement is potentially relevant to CERCLA activities. No readily available information suggests migratory birds frequent the project area, and aerial photography of the site suggests no suitable nesting or stopover habitat is present; however, a qualified biologist would perform a site visit prior to a potential remedial action to confirm that migratory birds do not frequent the project area.
Coastal Zone Management Act	16 USC §§1451 et seq. (implementing regulations at 15 CFR 930)	Federal activities must be consistent with, to the maximum extent practicable, State coastal zone management programs. Federal agencies must supply the State with a consistency determination (USEPA 1989).	The San Jacinto River lies within the Coastal Zone Boundary according to the Texas Coastal Management Plan (TCMP) prepared by the General Land Office (GLO). The FS considers whether the remedial alternatives would affect (adversely or not) the coastal zone, and the lead agency is required to determine whether the activity will be consistent with the State's CZMP (USEPA 1989). More information regarding the state requirements is provided under Texas Coastal Coordination Council (TCCC) Policies for Development in Critical Areas.
FEMA (Federal Emergency Management Agency), Department of Homeland Security (Operating Regulations)	42 U.S.C. 4001 et seq. (implementing regulations at 44 CFR Chapter 1)	Prohibits alterations to river or floodplains that may increase potential for flooding.	This requirement is relevant to CERCLA activities in floodplains and in the river because the project area is within a designated flood zone. The FS includes a brief review of the potential impacts of remedial alternatives on the floodplain, and there will be a full evaluation of the selected alternative as part of the remedial design process.
National Flood Insurance Program (NFIP) Regulations	42 U.S.C. subchapter III, §§4101 et seq.	Provides federal flood insurance to local authorities and requires that the local authorities not allow fill in the river that would cause an increase in water levels associated with floods.	The FS includes a brief review of the potential impacts of remedial alternatives on the floodplain, and there will be a full evaluation of the selected alternative as part of the remedial design process.

[3] Texas Parks and Wildlife Department.

Table 1
Applicable or Relevant and Appropriate Requirements Summary

Potential ARARs[1]	Citation	Summary	Comment
Title 40: Protection of the Environment - Statement of Procedures on Floodplain Management and Wetlands Protection	40 CFR Part 6 App. A; Executive Orders (EO) 11988 and 11990	Requires Federal agencies to conduct their activities to avoid, if possible, adverse impacts associated with the destruction or modification of wetlands and occupation or modification of floodplains. Executive Orders 11988 and 11990 require Federal projects to avoid adverse effects and minimize potential harm to wetlands and within flood plains. The EO 11990 requires Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative (USEPA 1994).	This requirement is potentially relevant to disposal or treatment activities in the upland as well as any in-water facilities that might displace floodwaters. The waste pits are located within the floodway and Zone AE, or the 1% probability floodplain. The FS includes a brief review of the potential impacts of remedial alternatives on the floodplain, and there will be a full evaluation of the selected alternative as part of the remedial design process. Effects on the base flood, typically the 100-year or 1% probability flood, should be minimized to the maximum extent practicable (Code of Federal Regulations 1985 as amended). The agency also adopted a requirement that the substantive requirements of the Protection of Wetlands Executive Order must be met (USEPA 1994). Unavoidable impacts to wetlands must be mitigated (USEPA 1994)[4].
National Historic Preservation Act	16 U.S.C. §§ 470 et seq. (implementing regulations at 36 CFR 800)	Section 106 of this statute requires Federal agencies to consider effects of their undertakings on historic properties. Historic properties may include any district, site, building, structure, or object included in or eligible for the National Register of Historic Places (NRHP), including artifacts, records, and material remains related to such a property.	According to the San Jacinto River Waste Pits Remedial Investigation/Feasibility Study (RI/FS) cultural resources assessment, "no NRHP-eligible properties are documented in the area of concern. Because of the extensive disturbance to the site and minimal ground disturbance that will likely occur for the project, it is not likely that NRHP-eligible historic properties will be affected by RI/FS or eventual site remediation activities" (Anchor QEA 2009).
Noise Control Act	42 U.S.C. §§ 4901 et seq. (implementing regulations at 40 CFR Subchapter G §201 et seq.	Noise Control Act remains in effect but unfunded (USEPA 2010).	Noise is regulated at the state level. See Texas Penal Code under state ARARs.
Hazardous Materials Transportation Act	49 U.S.C. §§1801 et seq. (implementing regulations at 49 CFR. Subchapter C)	Establishes standards for packaging, documenting, and transporting hazardous materials.	This requirement would apply to remedial alternatives that involve transporting hazardous materials off-site for treatment or disposal.

[4] Each agency is expected to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands when implementing actions such as CERCLA sites (President of the United States 1977). If §404 of the Clean Water Act is considered an ARAR, then the 404(b)(1) guidelines established in a Memorandum of Understanding (MOU) between USEPA and Department of Army should be followed (USEPA 1994). When habitat is severely degraded, a mitigation ratio of 1:1 may be acceptable (USEPA 1994). However, any mitigation would be at the discretion of the agency and the USEPA may elect to orient mitigation towards "minimizing further adverse environmental impacts rather than attempting to recreate the wetlands original value on site or off site" (USEPA 1988).

Table 1
Applicable or Relevant and Appropriate Requirements Summary

Potential ARARs	Citation	Summary	Comment
State			
30 Texas Administrative Code (TAC) Part 1: Industrial Solid Waste and Municipal Hazardous Waste General Terms	30 TAC §§335.1 – 335.15	General Terms: Substantive requirements for the transportation of industrial solid and hazardous wastes; requirements for the location, design, construction, operation, and closure of solid waste management facilities.	Guidelines to promote the proper collection, handling, storage, processing, and disposal of industrial solid waste or municipal hazardous waste in a manner consistent with the purposes of Texas Health and Safety Code, Chapter 361. Solid nonhazardous waste provisions are applicable if material is transported to an upland disposal facility.
30 TAC Part 1: Industrial Solid Waste and Municipal Hazardous Waste: Notification	30 TAC Chapter 335 Subchapter P	Requires placement of warning signs in contaminated and hazardous areas if a determination is made by the executive director of the Texas Water Commission a potential hazard to public health and safety exists which will be eliminated or reduced by placing a warning sign on the contaminated property.	Warning signs and fencing were placed around the site as part of the Time Critical Removal Action. The FS includes additional institutional controls for all alternatives, including additional warning signs and fencing.
30 TAC Part 1: Industrial Solid Waste and Municipal Hazardous Waste: Generators	30 TAC Chapter 335, Subchapter C	Standards for hazardous waste generators either disposing of waste on-site or shipping off-site with the exception of conditionally exempt small quantity generators. The definition of hazardous involves state and Federal standards.	The sludge and sediment at the site are not listed hazardous waste, do not contain listed hazardous waste, and do not meet any of the characteristics of hazardous waste. Therefore, the rules for hazardous waste are neither applicable nor relevant and appropriate.
Texas Surface Water Quality Standards	30 TAC §307.4-7, 10	These state regulations provide: • General narrative criteria • Anti-degradation Policy • Numerical criteria for pollutants • Numerical and narrative criteria for water-quality related uses (e.g., human use) • Site specific criteria for San Jacinto basin	Surface water quality standards are potentially relevant to the determination of risks, but should not override any site-specific toxicity values or risks determined through the risk assessment process. It is also relevant to the identification of potential sources and the short-term and long-term effectiveness of removal alternatives. However, the surface water quality criterion for TEQ, expressed as a concentration in edible fish tissue in 30 TAC §307.6 (c) 11, is generally not being met throughout the Houston Ship Channel, San Jacinto Bay and Galveston Bay areas. In more than 90 percent of edible fish tissue samples and in more than 85 percent of edible crab tissue collected by Respondents, TCEQ and TDSHS outside of USEPA's Preliminary Site Perimeter from 2002 through 2011, TEQ concentrations exceeded this tissue-based standard. Therefore, applicability to evaluation of effectiveness is limited due to ambient conditions in the region.
Texas Water Quality: Pollutant Discharge Elimination System (TPDES)	30 TAC §279.10	These state regulations require stormwater discharge permits for either industrial discharge or construction-related discharge. The State of Texas was authorized by USEPA to administer the NPDES program in Texas on September 14, 1998 (Texas Commission on Environmental Quality 2009).	The proposed remedial alternatives evaluated in the FS do not include off-site remedial action beyond disposal of sediments in upland disposal facilities that would be previously permitted, and therefore no discharge permit for off-site remedial actions would be required.
Texas Water Quality: Water Quality Certification	30 TAC §279.10	These state regulations establish procedures and criteria for applying for, processing, and reviewing state certifications under CWA, §401. It is the purpose of this chapter, consistent with the Texas Water Code and the Federal CWA, to maintain the chemical, physical, and biological integrity of the state's waters.	The development and evaluation of remedial alternatives will include consideration of potential water-quality impacts, relevant to the Water Quality Certification in Texas. Although permits are not required for on-site CERCLA actions, water quality certification is relevant as part of identification of substantive state ARARs (USEPA 1988).
Texas Risk Reduction Program	30 TAC §350	Activated upon release of Chemicals of Concern (COC). The Risk Reduction Program uses a tiered approach incorporating risk assessment techniques to help focus investigations, to determine appropriate protective concentration levels for human health, and when necessary, for ecological receptors. Includes protective concentration levels.	Risk assessment was performed as part of the remedial investigation. Sediment and soil contaminated with COCs is isolated from potential receptors by existing soil and sediment or the TCRA cap such that there are no unacceptable risks to human health or the environment. The remedial alternatives would increase the permanence of the existing barriers to exposure, thereby enhancing the risk reduction.
Natural Resources Code, Antiquities Code of Texas	Texas Parks and Wildlife Commission Regulations 191.092-171	Requires that the Texas Historical Commission staff review any action that has the potential to disturb historic and archeological sites on public land. Actions that need review include any construction program that takes place on land owned or controlled by a state agency or a state political subdivision, such as a city or a county. Without local control, this requirement does not apply.	Assessment of historical resources during the TCRA produced no known eligible properties and determined that disturbance of any archaeological or historic resources is unlikely within the TCRA Site. Depending on the magnitude and specific boundaries of ground disturbance determined during the FS for the overall site, this ARAR will need to be re-evaluated relative to CERCLA activities outside of the TCRA boundaries. (Anchor QEA 2009).

Table 1
Applicable or Relevant and Appropriate Requirements Summary

Potential ARARs	Citation	Summary	Comment
Practice and Procedure, Administrative Code of Texas	13 TAC Part 2, Chapter 26	Regulations implementing the Antiquities Code of Texas. Describes criteria for evaluating archaeological sites and permit requirements for archaeological excavation.	This requirement is only applicable if an archaeological site is found; based on evaluations conducted as part of the RI/FS and TCRA processes, it is unlikely that archaeological resources would be found on the Site
State of Texas Threatened and Endangered (T&E) Species Regulations	31 TAC 65.171 - 65.176	No person may take, possess, propagate, transport, export, sell or offer for sale, or ship any species of fish or wildlife listed as threatened or endangered.	The presence or absence of state T&E species was evaluated in 2010, and concluded that no state T&E species were likely to occur on the Site or in the vicinity.
TCCC Policies for Development in Critical Areas	31 TAC §501.23	Dredging in critical areas is prohibited if activities have adverse effects or degradation on shellfish and/or jeopardize the continued existence of endangered species or results in an adverse effect on a coastal natural resource area (CNRA)[5]; prohibit the location of facilities in coastal natural resource areas unless adverse effects are prevented and /or no practicable alternative. Actions should not be conducted during spawning or nesting seasons or during seasonal migration periods. Specifies compensatory mitigation.	The FS evaluates the potential effects of remedial alternatives on Coastal Natural Resource Area (CNRAs), which includes coastal wetlands (Railroad Commission of Texas n.d.).
Texas Coastal Management Plan (CMP) Consistency	31 TAC, §506.12	Specifies Federal actions within the CMP boundary that may adversely affect CNRAs; specifically selection of remedial actions.	The San Jacinto River lies within the Coastal Zone Boundary (GLO TCMP). The FS will evaluate whether remedial alternatives may affect (adversely or not) the coastal zone and will provide a technical basis for the lead agency to determine whether the activity will be consistent with the State's CMP (USEPA 1989).
Texas State Code – obstructions to navigation	Natural Resources Code § 51.302 Prohibition and Penalty	Prohibits construction or maintenance of any structure or facility on land owned by the State without an easement, lease, permit, or other instrument from the State.	The FS evaluates whether the remedial alternatives include construction on state-owned land, and implementation of any alternative occurring on state lands presumes the obtainment of an easement, lease, permit, or other instrument from the State.
Noise Regulations	Texas Penal Code Chapter 42, Section 42.01	The Texas Penal Code regulates any noise that exceeds 85 decibels after the noise is identified as a public nuisance.	Noise abatement may be required if actions are identified as a public nuisance. Due to the isolation of the site, its location adjacent to a freeway with high volumes of traffic during normal working hours, and the industrial nature of the nearest properties, noise from construction activity associated with a potential remedial action is unlikely to constitute a public nuisance. Noise associated with truck traffic to and from the site should be considered for alternatives that involve transportation of materials off-site.

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[5] A CNRA is a coastal wetland, oyster reef, hard substrate reef, submerged aquatic vegetation, tidal sand, or mud flat.

Table 1
Applicable or Relevant and Appropriate Requirements Summary

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SITE FIGURES